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International review of action to improve world protein nutrition

THE PAG BULLETIN

Purpose

The PAG Bulletin is published by the Protein Advisory Group of the United Nations System. Its purpose is to give information on the world protein problem to those individuals, academic institutions and industrial organizations which are interested in helping solve the protein problem and to promote the exchange of information in this field.

Mailing list

The PAG Bulletin is sent without charge to persons, organizations, and companies with an active interest in proteins. The present mailing list comprises about 4500 names, approximately fifty per cent in the U. S. A. and the rest distributed throughout the world. Requests to be added to the mailing list for the PAG Bulletin should be addressed to the Director of Secretariat, Protein Advisory Group of the United Nations System, United Nations, N. Y. 10017, U. S. A. Recipients are urged to share their copy with their colleagues.

Quotation

Permission to quote items from the PAG Bulletin is not required except from authors of signed articles. The Secretariat of the PAG would appreciate being informed of quotations made from the PAG Bulletin.

Suggestions

The PAG Bulletin will be successful only if it reflects all aspects of the protein problem comprehensively and objectively. The Secretariat invites suggestions and ideas for broadening and deepening the scope of the PAG Bulletin.

Secretariat

Staff members of the PAG Secretariat are:

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Mrs. Charlotte S. Kouris	Editorial Assistant
Mrs. Rosanne Burgaretta	Clerical Secretary
Miss Milena Peluchova	Clerical Secretary
Mrs. Mary Toumayan	Clerical Secretary

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A recent meeting of the PAG's most active working group offered recommendations on three topics: standards and regulations for special foods for infants and young children; the need for legislation for protection of working women during pregnancy and lactation; and the use of home-prepared legumes and green leafy vegetables for infant and child feeding. Page 1.

- Fortification of Skim Milk Powder with Vitamins A and D

The history of vitamin A and D fortification of skim milk powder distributed for child feeding in international programs is reviewed and its importance for prevention of blindness is stressed. While some countries are providing the fortified product, others are not, and correction of this situation is urged. Desirable fortification levels are indicated. Page 2.

- Processed Weaning Foods

Large quantities of cereal-based, protein-fortified foods for weaning and supplementary feeding of young children have been distributed and used with considerable benefit in international food donation programs. Donated foods do not, however, provide a satisfactory long-term solution in developing countries where the answer lies in local production, marketing and distribution of such products. Recently, when reviewing this problem, the PAG listed twelve points which must be considered when carrying out such programs in developing countries. Page 2.

- The "Protein Problem"

Because certain misunderstandings have arisen concerning the PAG's precise position on the global problem of protein-calorie malnutrition, the Group recently reviewed and clarified its philosophy and viewpoints. The document defines the protein problem in the context of a series of questions such as: Is there a protein gap? Is there a protein problem? Is there a protein problem for adults in developing countries? Cannot protein-calorie malnutrition be prevented by increasing the quantity of the traditional diet? Do populations adapt to protein-calorie deficiency and thereby lower their requirements for food? Will not the protein problem be solved by increased income? Is protein wasted when calories are deficient? Page 4.

- PAG Guideline (No. 14) on the Preparation of Defatted Edible Sesame Flour

Sesame seed, an important oilseed crop widely grown in tropical and subtropical areas, provides a nutritious protein concentrate when the edible oil component is removed. This guideline, prepared with the assistance of specialists, lists useful procedures for the processing of such concentrates and the chemical, nutritional and sanitary qualities which they should have. Page 10.

- PAG Guideline (No. 13) for the Preparation of Milk Substitutes of Vegetable Origin and Toned Milk Containing Vegetable Protein

In many countries where animal milks are scarce and expensive it is feasible to produce highly acceptable milks from vegetable proteins (e.g. from soybeans, peanuts or sesame seed) or to use such vegetable milks for extending (toning) animal milk supplies. This guideline, prepared by experts in this field, suggests suitable processing procedures, composition characteristics and quality criteria which should be observed when manufacturing such food products. Page 14.

- Commercial Production of Leaf Protein for Animal and Human Use by E. M. Bickoff and G. O. Kohler

Processes for the production of edible protein concentrates from fresh leaves have been under development for many years but their application to human feeding is still limited. The authors have developed a new processing concept and technology (the PRO-XAN process) based on utilization of commercially-grown fresh alfalfa, which appears economically attractive. A by-product from the expressed alfalfa juices, a pigment concentrate valuable for poultry feeding

which is already distributed on a commercial basis, seems to assure the production of edible protein concentrates at reasonable cost. Page 19.

- The Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research by P. A. Oram

An earlier paper in this journal (Vol. II, No. 3, 1972) reported on the establishment of the Consultative Group on International Agricultural Research and the related activities of TAC. The present report provides detailed information of progress achieved by TAC in identifying the need for research to improve a number of primary food staples grown in tropical and subtropical environments, and the role of various regional agricultural research institutes in carrying out such efforts with financial assistance from the consultative group. TAC's recommendations emphasize improvement of millet and sorghum, the need to strengthen food legume research, research in Africa on the diseases and productivity of farm animals, rice development in West Africa, potato improvement in Latin America, and other priorities. Page 20.

- Single-Cell Protein: Which One Do You Mean?

This article, reprinted from the British Nutrition Foundation Bulletin, makes the point that the term single cell protein (SCP) embraces a wide variety of yeasts, bacteria, fungi and algae which are currently being studied as protein sources. There is a danger that the properties of any one of these organisms, which may differ very widely from the others, might be construed to apply to all. This could lead to serious misunderstanding of the problems of safety and nutritional value inherent in some of these species. Page 23.

- The Efficient Use of World Protein Supplies by Dr. John C. Abbott

Economic considerations and limitations will determine the production and use of world protein resources, particularly those of the unconventional type. Such factors include consumer income and attitudes, food traditions, education, available marketing systems, and the traditional trade movements of protein supplies which may divert protein into world markets from countries whose people are badly in need of this nutrient. Page 25.

- Recent Meetings

Miscellaneous Items and Announcements

PAG *AD HOC* WORKING GROUP MEETING ON FEEDING THE PRESCHOOL CHILD*

The following three subjects were discussed at the meeting: standards and regulations for special foods for infants and young children; the need for legislation for protection of working women during pregnancy and lactation; and use of home-prepared legumes and green leafy vegetables for infant and young child feeding.

The Working Group had the opportunity to review the recent reports of the Codex Committee on Foods for Special Dietary Uses pertaining to infant formulas and cereal-based processed foods for infants and children. Comments were offered both on the nutritional composition of the products and on the need for a clearer definition of the purpose for which these products will be used in the developed and developing countries. General recommendations were made with regard to the principles and guidelines underlying the composition, sanitary conditions and safety, nutritional content, labeling requirements, marketing and production and subsidized distribution of protein-rich foods. The *ad hoc* Working Group's report has been made available to the Secretariat of the Codex Alimentarius Commission.

The ill effects of poor diet and malnutrition on the pregnant woman, the offspring and the woman's capacity to breast feed after delivery are considerably multiplied and aggravated in the case of working women who are employed under unsatisfactory conditions outside their homes. The Group was particularly concerned with the inhibitory effects of the working environment on breast feeding and the serious consequences of this for the young infant. The current legislative practices in different countries were reviewed briefly and the Group recommended that the duration fixed for postnatal leave should take into consideration the needs of the infant and the emotional aspects of the mother-child relationship. The special problems in the developing countries were examined and the need for coordinating maternity protection measures with other MCH and family planning legislation was stressed.

Legumes are recognized to be one of the best plant sources of protein and are also a dietary source of some vitamins and minerals. Edible green leafy vegetables are good sources of several micronutrients. Nevertheless, these foodstuffs are rarely introduced into young children's diets in the developing countries. Admittedly there are a few problems in their regular use in infant and child feeding. The more important of these are cultural prejudices, presence of toxic and other irritant factors, and poor digestibility.

The Group considered the practical steps necessary to overcome some of these difficulties and thus to stimulate the use of legumes and edible green leafy vegetables as a part of the regular daily diet of young children in developing countries. The need for more information on certain nutritional and agricultural aspects of these two important foodstuffs was stressed and topics for further study and research were listed. The Group's recommendations will be considered at the 21st PAG Meeting in June 1973.

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*The Working Group which met at the World Health Organization Headquarters, Geneva, Switzerland, on 11 to 13 December, 1972, consisted of Dr. Bo Vahlquist (Chairman), Sweden; Mr. O. Ballarin, Brazil; Dr. J. Cravioto, Mexico; Dr. M. Gabr, Egypt; Dr. D. B. Jelliffe, U.S.A.; Mr. E. de Liniéres, France; and Dr. S. G. Srikantia, India. Mr. D. Cox, U.S.A.; Mr. D. Benton, U.S.A.; and Mr. H. R. Mueller, Switzerland, attended as consultants. Dr. N. S. Scrimshaw was also present. Agencies represented were FAO, WHO, UNICEF and ILO.

FORTIFICATION OF SKIM MILK POWDER WITH VITAMINS A AND D*

Evidence from WHO investigations and other sources clearly shows vitamin A deficiency to be a public health problem in developing countries in most parts of the world. It is especially severe in a number of countries in Southeast Asia where this deficiency is one of the main causes of blindness in children. One of the earliest recommendations of the PAG was that skim milk powder distributed by UNICEF should be fortified with vitamin A. UNICEF arranged to have skim milk powder donated to it by the U. S. Government fortified with the relatively stable "beadlet" (microencapsulated) form. Soon afterward, the U. S. Government adopted a policy of fortifying all skim milk powder donated under Title II (Food for Peace) feeding programs. Milk donated by European countries, however, is still unfortified. This is generally undesirable and is a potential hazard even if the skim milk powder is intended for a country where vitamin A deficiency is not a serious problem. Shipments of food are sometimes diverted for emergency use in populations already deficient in vitamin A. In a recent emergency in Asia severe eye lesions and blindness were a serious problem which was exacerbated by distribution of unfortified skim milk powder. Standardized cereal-based mixtures which are fortified with protein concentrates, minerals and vitamins, including vitamin A, are in wide use under both normal and emergency circumstances. There is a risk, however, in any assumption that skim milk powder is always fortified with vitamin A. All skim milk powder used in feeding programs in developing countries should be so fortified; until this is done, the label should state that the product does not contain vitamin A.

The original PAG recommendation included vitamin D fortification and this has been done in the U. S. Government program. Since rickets continues to be a problem in a number of developing countries, it is recommended that skim milk powder be fortified also with vitamin D.

The levels recommended for stabilized forms of the vitamins are 1, 500 mcg retinol** and 12. 5 mcg cholecalciferol*** per 100 grams of skim milk powder, assuming intakes in the range of 40 to 80 grams of skim milk powder per day.

*A recommendation made at the 20th PAG Meeting, June 1972.

**Equivalent to 5, 000 international units of vitamin A.

***Equivalent to 500 international units of vitamin D.

PROCESSED WEANING FOODS*

The PAG since its inception has encouraged the development and marketing of processed cereal-based, protein-enriched food mixtures suitable for the supplementary feeding of breast-fed infants and young children, just as cow's milk is used in the diets of young

*A recommendation made at the 20th PAG Meeting, June 1972.

children during and after weaning. A review of locally-processed food mixtures for infants and young children reveals steady progress in a number of countries. Mixtures such as Pronutro and Incaparina have been commer cially successful for a number of years and have stimulated not only similar commercial efforts but also the development of CSM (1) and other formulas. These have been donated in enormous quantities (four billion pounds of CSM alone since 1966) for use in feeding programs in developing countries throughout the world. Both commercial and free distribution have demonstrated the acceptability and nutritional effectiveness of foods of this kind.

Thus far, mass distribution without direct cost to the consumer of such foods as CSM (1), WSB (2) and Bal Ahar (3), in government-sponsored or approved supplementary feeding programs of various types, has had a far greater quantitative impact than locally-produced and distributed mixtures. However, donated foods are not a satisfactory long-term solution for the developing countries where milk and other foods of high protein value are costly or unavailable to low income groups. In most of the countries in which donated foods of this type are being distributed on a large scale, through donation programs, there is as yet no equivalent local production.

Fortunately, experience is accumulating in the development of special children's foods for local markets and there is evidence of an increasing success for new locally-manufactured weaning foods distributed through commercial and welfare channels. This is due to improvements in technology, marketing strategies, and government cooperation and support. Despite progress, such local mixtures are available in relatively few countries and their availability to vulnerable groups is still limited. It is apparent that more intensive efforts, a higher level of investment by both industry and government, greater support from bilateral and multilateral agencies and more emphasis on marketing is required if these foods are to achieve their full potential for nutritional impact.

The PAG reaffirms its previous recommendations and those of the United Nations Secretary-General's Report "Strategy statement on action to avert the protein crisis in the developing countries"* that weaning foods based primarily on local oilseed proteins, legumes and cereals be developed in those countries with an adequate market and in which animal milks and other foods cannot meet the needs of vulnerable groups.

The PAG urges that for the future conduct of such programs, particular care and attention be given to:

a) Preparatory market and consumer research studies which analyze the behavioral factors affecting acceptance of new foods and the foundation of product concepts.

b) Comprehensive surveys of potential demand and the effect of pricing policies on it.

c) Maximum use of local raw-material manufacturing, marketing and manpower resources in product and project development.

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(1) A mixture of processed corn meal, defatted soy flour and skim milk powder, fortified with vitamins and minerals, provided to international feeding programs by the U.S. Food for Peace Program.

(2) A mixture of wheat flour or ground bulgur supplemented with wheat protein concentrate and defatted soy flour and fortified with vitamins and minerals, supplied by the Food for Peace Program.

(3) A mixture of wheat flour, peanut flour and skim milk powder, fortified with vitamins and minerals, processed and distributed in India. In Hindi, the term "Bal Ahar" means "children's food".

*E/5018/Rev. 1. Available from U.N. sales offices as E.71.II.A.17.

d) Assessment of the optimum price to consumers which will support market development and, simultaneously, exploration of economies to make the product available at least possible cost to the vulnerable groups most in need.

e) Provision of government assistance, as appropriate, in the form of tax relief, financial and economic incentives, mass media and other contributions to product promotion, bulk purchase for institutional feeding and other measures which will facilitate provision of protein food mixtures to needy groups.

f) Recognition and promotion of local production by the World Food Programme and other major international sources of aid through donation of appropriate raw material or ingredient components or the purchase and distribution of locally-produced products.

g) Strategic planning for the long-term market development cycle which is normally needed for protein food mixtures introduced to meet nutritional objectives and which may require significant changes in food habits.

h) Encouragement of governments to enact and enforce legislation relating to food standards which will result in products with acceptable nutritive value and safety being available either through local manufacture or imports.

i) Increasing the prospects for economic viability by planning for diversified production and products. This should include variations of the basic product and the possibility of production and distribution of enriched, fortified staple foods in addition to weaning foods.

j) Broadening of research objectives; while process/product development and improvement may be required, consumer behavior in relation to marketing may be of higher priority in the early years of a project.

k) Training of key personnel in technological, marketing/promotion and managerial capacities; in this regard, in-plant training at similar processing facilities already operating in another developing country should be encouraged.

l) Transfer of technology. By and large the technology for such mixtures is already available and need not be redeveloped in each country; all stages of developmental research need not be repeated. The United Nations and bilateral agencies can be of particular assistance in this regard, as can experienced industries in the industrialized countries.

PAG STATEMENT (No. 20) ON THE "PROTEIN PROBLEM"*

The PAG from its inception has dealt with protein-calorie malnutrition and has always considered protein deficiency in relation to the concomitant need for calories and other essential nutrients. The term protein-calorie malnutrition (PCM) includes many different clinical syndromes, all of which are accompanied by retardation of growth and development. The manifestations of PCM vary widely, depending on the nature of the causative factors, the time for which they operate, and the age of the patient. Two severe clinical forms are recognized: nutritional marasmus and kwashiorkor. The former results from deprivation of protein and calories to a similar degree and the latter is due primarily

* Statement prepared at the 20th PAG Meeting and subsequently adopted by the PAG.

to a protein deficiency relative to energy intake but may be superimposed on any degree of marasmus and is commonly precipitated by infectious episodes. While in some areas PCM could be reduced by increased consumption of cereal-based diets, provided they can meet both protein and calorie needs, foods richer in protein than these would make easier the prevention of such malnutrition and are essential for its treatment. In populations for which starchy roots or tubers make up the basic dietary staple, better sources of protein are essential for both prevention and treatment of the PCM associated with such diets. The more that either cereal- or tuber-based diets are supplemented by legumes, the less the need for introducing other protein-rich foods of animal or plant origin.

The increased cereal production resulting from the Green Revolution that has occurred in some developing countries has not eliminated the concern for ensuring adequate protein in the diets of their populations. This is because the increased production has been almost entirely confined to cereal grains that do not in themselves contain sufficient high-quality protein relative to their bulk and caloric value to meet the optimum needs of young children, particularly those in unfavorable circumstances.

On the contrary, the Green Revolution has accelerated a long-term trend toward a decrease in per caput production, as well as an increase in price, of the legumes that have been the traditional sources of more concentrated protein to supplement predominantly cereal diets. Furthermore, in those areas of the world where the diet is still composed mostly of starchy roots (e.g. cassava, Manihot utilissima), tubers (e.g. yams, Dioscorea, Colocasia, Xanthosoma spp.) or fruits (e.g. plantain, Musa sapientium var. paradisiaca), there is often an urgent need to increase protein consumption. The primary purpose of the PAG is to assure that the preschool child and other vulnerable groups receive a diet adequate in both protein and calories as well as in other essential nutrients.

It is also apparent that with the continuing rapid increase in world population it will be far easier to provide the basic staple, whether it is a cereal or starchy root, tuber, or fruit, than it will be to provide the legume, oilseed, or animal protein needed in addition by major vulnerable segments of the population: infants and young children, pregnant and lactating women, and persons under the stress of infectious or other diseases. For this reason, the PAG continues to emphasize the desirability of genetic improvement in the protein characteristics of cereals and other staple food crops, enrichment of staple diets with good sources of plant or animal protein, research and fiscal policies that will improve legume and oilseed production for human feeding, improvement of animal protein supplies and, where this is not feasible the development of vegetable protein mixtures that can serve in place of animal protein for infant and child feeding.

The PAG recognizes that a dietary deficiency of calories relative to protein is wasteful of protein. It is also clear that provision of extra calories from starchy roots and tubers or from sugar and fat without ensuring adequate protein is of limited value.

Analysis of protein needs relative to calories is complicated by the fact that the safe minimum allowances for dietary intake of protein and calories as proposed by FAO/WHO experts* are not satisfactory criteria for determining the relative adequacy of protein and calories for vulnerable groups in developing countries. The allowances are for the needs of healthy individuals and underestimate requirements for persons exposed to chronic or recurrent acute infections. The metabolic losses of tissue protein during acute infections result in significantly increased protein needs during convalescence. Absorption of protein may also be reduced by the effects of recurrent enteric infection on the gastrointestinal mucosa

*Energy and protein requirements. 1973. Report of the Joint Expert Group of FAO/WHO.

and by the presence of intestinal parasites.

Of critical importance is the fact that per caput estimates of protein needs do not take into account the effects of maldistribution within social and economic groups and among family members. If people can afford it and supplies permit, they eat far more protein than they appear to require according to current estimates for healthy individuals. Food available within a family may be consumed disproportionately by adults or working males and often not enough of the foods richer in protein than the basic staple is allotted to young children or other vulnerable family members. For these reasons, per caput food and nutrient availability figures can be quite misleading. Direct examination of feeding practices and health conditions among individuals in the vulnerable groups is more informative, but must be interpreted in the light of the added requirement for protein imposed by the factors mentioned.

The PAG recognizes and emphasizes that the protein problem cannot be solved from the supply side alone. It requires an increase in the demand for appropriate protein foods for the feeding of vulnerable groups whether the limiting factor is lack of purchasing power or inadequate knowledge. Environmental, educational and public health measures to reduce the burden of infection on vulnerable groups are also essential

Because the protein problem is due to inadequate distribution of protein foods to vulnerable groups relative to their needs, it is largely independent of per caput protein availability. Moreover, it does not necessarily require solution by the introduction of unfamiliar foods. It could be met by better distribution of food within the family or by increased use of legumes or of animal protein by the groups in need. Nevertheless, processed foods utilizing relatively inexpensive protein of vegetable origin can be very useful for both the prevention and treatment of PCM, especially for urban populations.

The name Protein Advisory Group has caused misunderstanding about the PAG's attention to calories and other nutrients as well as protein. A change to Protein-Calorie Advisory Group has been considered but was rejected because a special effort was needed in programs of the United Nations system to ensure adequate dietary protein relative to calories. The need for adequate calories has been more generally recognized and major efforts to increase calorie supplies are underway. The PAG also reviews special problems which arise with regard to safety and suitability of new sources of protein, particularly for younger children.

The following questions are among those most frequently asked about the "Protein Problem", and the PAG position is concisely summarized.

1. Is there a protein gap?

If one looks at figures for world and per caput availability of protein, the answer is no. FAO's Agricultural Commodity Projections for 1970 to 1980, based upon national food balance sheet data submitted to FAO by Member Governments, were calculated according to safe levels of intake recommended by the FAO/WHO Expert Committee report (1973) on protein requirements for healthy men, women, children and infants. These projections show that the per caput level of protein supplies available for human consumption exceeds those safe levels by 70%. Further confirmation of the accuracy of the information derived from food balance sheets and clearer definition of what constitutes safe levels of protein intake are needed, but there is no doubt that there is enough dietary protein in the world if there were any way it could be distributed according to need. However, there is much evidence that protein foods are not distributed in direct proportion to individual need. The data available indicate that the amounts of both protein and calories actually reaching the pre-school child are seriously inadequate in most of the developing countries. These inadequacies, coupled with recurrent episodes of infectious disease, are the cause of the widespread protein malnutrition seen in the world today.

2. Is there a protein problem?

The answer is yes. The continuing high

prevalence of protein-calorie malnutrition* among children of the developing countries is prima facie evidence that suitable foods are not provided to such children, and, in many countries, that cultural practices deny young children sufficient access to protein foods. Suitable foods would, of necessity, provide relatively concentrated sources of energy and would be adequate in protein and other nutrients. Increased cereal production alone will not improve this situation to any significant degree. In this sense, the assurance of a supply and consumption of suitable protein-rich foods for vulnerable groups is a continuing "protein problem".

In some cases the deficiency is equally one of calories and protein, but the protein component of the deficiency is frequently of special concern. This is because foods containing high-quality protein are inequitably distributed between developed and developing regions of the world, between high and low socioeconomic groups within countries, and within households where the vulnerable members rarely receive a share of the available protein foods commensurate to their needs.

The problem arises from:

a) low wages and income, and underemployment or unemployment in rural or urban areas, all of which limit the purchase of the relatively costly foods that contain protein of good quality,

b) difficulties associated with the production of protein-rich foods of animal or plant origin because of ecological and agricultural limitations with the result that they are usually costly and in relatively short supply,

c) the lack of effective food processing, distribution and marketing systems resulting in loss of food crops, and

d) lack of knowledge of food values and food preparation for children and specific prejudices against giving some protein foods to young children, especially when they have an infectious illness.

3. Is there a protein problem for adults in developing countries?

Not if the basic staple is wheat or millet, consumed in adequate quantities to meet caloric needs, and if individuals stay healthy. This is also the case, with less margin, for populations eating sorghum, rice or maize at adequate energy levels. However, optimum recuperation from severe infections, especially if repeated or chronic, and from trauma, requires a diet higher in protein value than that supplied by cereal-based diets if they are nearly devoid of animal protein and very limited in legumes and pulses. When starchy roots, tubers, or plantain are the staple, the poor may have insufficient other protein foods in their diet to make up for the small amounts of protein in these staples.

4. Cannot protein-calorie malnutrition be prevented by increasing the quantity of the traditional diet?

In some areas of the world this may be the case, but in most developing countries it is unlikely. For young children, particularly those under three years of age, the traditional diet is frequently so bulky that they have difficulty in eating enough of it to meet fully either calorie or protein needs. It really depends on whether the traditional diet contains enough supplementary animal or plant protein of good quality to meet not only the recommended allowances for healthy children but also to cover the needs of those

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*The milder, generally subclinical, forms of protein-calorie malnutrition (PCM) are almost ubiquitous among children in lower income families in developing countries, and the frank clinical diseases of kwashiorkor and marasmus and various combinations of the two continue to occur in most of these countries. The nature and frequency of these various forms of PCM are described in the most recent report of the FAO/WHO Joint Expert Committee on Nutrition (World Health Organization Technical Report Series No. 477, Geneva, 1971).

suffering from the diarrheal and other infectious diseases that are frequent among young children in developing countries.

Traditional diets may be improved with respect to protein through home preparation of foods such as legumes (1). In some situations, a processed weaning food mixture containing vegetable protein may be the most practical substitute for the traditional role of animal milks in child feeding. However, this approach is primarily applicable to urban populations and even there the lowest income groups may have difficulty in purchasing sufficient quantities of these foods.

In those areas where fibrous and starchy foods make up much of the diet, it is essential to reduce the bulk by increasing the concentrations of energy and protein in weaning foods. This would necessitate attempts to reverse cultural prohibitions that preclude offering sufficient legumes and animal protein foods to weanlings and toddlers. In any area where the staple foods given to young children are very low in protein, protein-rich foods must be added to the diet.

5. Do populations adapt to protein-calorie deficiency and thereby lower their requirements for food?

Not in a true sense. Adults adapt to calorie insufficiency by loss of body weight and reduction of voluntary work; children "adapt" by retarded growth rates, as well as by decreased activity. Such "adaptations" are unacceptable as national policy. The health and productivity of adults may be affected and for children the ultimate result may be impairment of physical and perhaps mental development.

6. Do some ethnic groups have lower requirements than others for protein and for calories?

Not so far as we now know, except that groups differ in requirements insofar as their body weights differ. Inadequate early feeding and frequent infectious episodes during early growth are largely responsible for the smaller body size of some ethnic groups. Recurrent infections in the people of the developing countries tend to increase their needs for protein and other nutrients. Energy requirements will vary with patterns of physical activity and, to some extent, with environmental temperatures.

7. Food legumes are good sources of protein. When they are used in conjunction with cereal diets, why is there a concern for adding still other types of protein to the diet?

The concern varies from one region to another and with the feeding practices of particular cultural groups. It depends upon the nature and amount of foods consumed in addition to the cereal staple. The amount of legume consumed relative to cereal is often very small, and the considerable bulk of a starchy diet with a poor ratio of protein to calories makes it extremely difficult for the young child to eat enough to meet his requirements. Under these circumstances, apart from increasing consumption of milk or other protein of animal origin, which may not be feasible, the alternatives are: a) to encourage consumption of more legumes with a smaller proportion of cereal, b) to supplement the cereal diet with a food of higher protein concentration such as peanut or soy preparations, or c) to introduce an entirely new food or food mixture which should be so formulated that it contains all the necessary nutrients, including synthetic amino acids if judged necessary to increase protein quality. Where cassava or starchy fruits form the primary staples, the need for protein supplementation is critical.

8. Why does the PAG consider that the safe levels of intake of protein recommended by the 1973 report of the FAO/WHO ad hoc Expert Committee on Protein and Calorie Requirements are inadequate for most children in developing countries?

They are presumably adequate for healthy children living in a relatively sanitary environment and infrequently ill, but such children are likely to be receiving more protein than they require anyway. Dietary protein needs of most young children in developing countries are increased, however, not only by the poorer absorption of dietary protein caused by intestinal

parasites and chronic damage to the gastro-intestinal tract from repeated infections, but also by the extra protein lost from the body during the acute infections so commonly experienced by such children. This loss is induced by the stress response, which causes amino acids to be mobilized from the protein in the lean body tissues for use by the liver in making glucose. In this process, protein nitrogen is lost through excretion in the urine in the form of urea. It must be replaced by dietary protein intakes above normal needs or the individual will become progressively more depleted in protein by such episodes. As a result, young children soon experience decreased resistance to infection and some may eventually develop kwashiorkor. The need for dietary calories may also be increased by impaired intestinal absorption and by fever, but the stress response is specific for protein. Moreover, a deficit in calories is compensated for to a considerable degree by reduced activity, but the body has no comparable mechanism for protein deficiency.

9. Will not the protein problem be solved by increased income?

General economic development deals with the root of the protein problem and offers, indeed, an effective long-term approach to its solution. However, there are substantial numbers in the vulnerable groups who will not receive sufficient incomes in the near future. Waiting a generation or two for economic development to do away with protein-calorie malnutrition means acceptance of continued high morbidity and mortality and of the impairment of physical and mental performance of future adults upon whom economic and social development depends. There is, therefore, a need for specific action programs for the nutritional protection of vulnerable groups. Attention to the nutritional needs of these groups, including the necessity for suitable protein-rich foods, will continue to be required for many years.

10. If kwashiorkor is caused by a deficiency of protein relative to calories, why does it occur in populations for whom dietary surveys show calories and protein to be equally deficient, or even when dietary calories appear to be more deficient than protein?

It is not easy to judge the relative adequacy of dietary calories and protein because, for reasons already indicated, protein needs may be greater than the "safe, practical allowances" recommended for healthy children. Desirable protein-calorie ratios have not been adequately defined. Furthermore, chronic and recurrent infections increase protein requirements. A deficiency of both protein and calories, i.e. a lack of food, leads to undernutrition and in severe cases marasmus; a severe deficiency of protein in a diet supplying adequate calories will result in kwashiorkor. Usually, however, the acute disease, kwashiorkor, develops only when some special stress situation, most commonly an infection, accentuates the deficiency of protein intake relative to caloric intake in a child whose previous diet, deficient in both protein and calories, has already led to undernutrition. The main reason for the development of kwashiorkor is not the balance of calories and protein in the usual diet but rather in the food given during and following an infectious episode such as measles or diarrheal disease. Under these circumstances, protein needs are increased more than those for calories, just when the diet is likely to be changed to barley water, rice water, or some other thin starchy gruel. A change in cultural practices for the feeding of young children during common infectious illnesses could help. Moreover, the nutritional impact of an infectious illness could be less if the child customarily consumed an adequate diet. The better solution, to the effect of infection on protein needs would be to decrease the burden of infectious disease instead of having to provide additional protein because of it. However, this requires considerable time and money and in the meantime, nutritional needs must be met.

Programs within the present resources of developing countries have unfortunately not been very effective in reducing the contact spread of respiratory and enteric infections among preschool children. The necessary environmental, educational and public health measures are enormously costly and will require many years to implement. In the meantime, provision must be made for the effect of acute and chronic infections on the nutritional needs of most preschool children in developing countries.

11. Is protein wasted when calories are deficient?

When calories are deficient, part of the protein in the diet is used to meet energy needs, but unless caloric restriction is severe, an improvement in protein quality or intake results in less loss of dietary protein. The addition of protein-rich foods is of benefit, therefore, even if full caloric adequacy is not achieved. This is wasteful of protein, however, so that in the long run, there can be no substitute for correcting the deficiency of both protein and calories through adequate food intakes.

12. Is the bulk in traditional diets a factor of significance in limiting intakes of protein and calories in developing countries?

If supplies and economic resources permit, adults can probably ingest sufficient amounts of their customary diets to provide at least their minimum requirements for energy and protein. Food is usually consumed at two or three meals per day.

The child under three years of age is often fed, or eats, at irregular times, but the physical bulk of the traditional diets in many developing countries is so great that he cannot consume enough food to meet protein and energy needs. In many parts of the world foods providing protein and calories in less bulk than in cereal are required to help meet these needs. Instruction of parents in the use of such foods, and in the better use of the food available to the family in feeding small children, is also of great importance.

Preschool children, three to five or six years of age, can generally consume sufficient quantities of cereal or cereal/legume diets containing only the traditional small amounts of legumes to meet their energy and protein needs if they are served four or five meals per day, but usually not if they follow the common adult eating pattern of two main meals per day. It is quite impossible for this age group to ingest sufficient quantities to meet requirements if the diet is based primarily on starchy roots (2).

References

1. Cameron, M., and Y. Hofvander. 1971. Manual on feeding infants and young children. Protein Advisory Group of the United Nations System, New York 10017, U.S.A. PAG Document 1.14/26.

2. Nicol, B.M. 1971. Protein and calorie concentration. Nutr. Rev. 29, No. 4:83.

PAG GUIDELINE (No. 14) ON THE PREPARATION OF DEFATTED EDIBLE SESAME FLOUR*

1. Introduction

Sesame (Sesamum indicum L., syn. Sesamum orientale L.) is an oilseed crop cultivated in many countries of Asia, Africa, and Central and South America. Because of high levels of sulfur amino acids and tryptophan in sesame protein, it is useful as a supplement in diets based on cereals and legumes which are generally consumed in the developing countries.

2. Process

2.1 Procedures. Sesame seed is commercially

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* Issued 11 October 1972. A number of internationally-known authorities assisted in the preparation of this guideline.

processed for oil in many areas where the crop is grown, but the seed is not dehulled before pressing. The presence of cuticle in the cake contributes undesirable color, bitterness and appreciable amounts of oxalates and crude fiber to the meal. Foreign matter such as sand in the commercial seed may be reflected in the acid-insoluble ash content of the meal. Dehulling of sesame is an essential prerequisite for the preparation of edible flour. The traditional method of dehulling involves soaking the seed in cold water followed by rubbing, washing and drying. Hot dilute lye solution used in place of water facilitates disintegration and easy removal of the hull. Numerous wet processing methods that may be capable of continuous commercial operation have been suggested (1-6). A dehulling process which works at very low moisture levels, based on a friction or abrasion technique, has also been developed (7). Any of these methods, if commercially feasible, can be applied to dehulling the seed.

The dehulled seed is screw-pressed*, then solvent-extracted, ground and sieved or classified in conventional equipment to obtain the flour. The plant and equipment should be maintained and operated under sanitary conditions as required for food production. The maximum temperature attained in cooking and pressing should not exceed 120°C (250°F). Solvents used for extraction, preferably hexane, should be of a quality adequate for food use as outlined in PAG Statement No. 21 (8).

An alternate method of preparing a low-fiber sesame flour from the nonhulled seed has also been developed (9). This consists of coarse grinding of the seed, direct solvent extraction of oil using hexane and then screening of the defatted material to eliminate the coarse hull fraction.

2.2 Raw materials. The commercial seeds used as raw material may be white, black or brown or a mixture of these, depending on the color of the outer coating. They should be clean, and free from molds and their toxins, insect infestation, extraneous matter, seeds of other crops and weed seeds. The seeds should be sufficiently dry for safe storage and should conform to the requirements given below.

Physical Condition	
Damaged or slightly damaged seeds, % by wt, max	7
Shrivelled and immature seeds, % by wt, max	4
Impurities, % by wt, max	2
Total of above, % by wt, max	7

Chemical Condition	
Moisture, % by wt, max	6
Oil (dry basis), % by wt, min	45**
Acid value of oil, % by wt of oil, max	2
Protein (dry basis), % by wt, min	18

*Many specialists have expressed the view that screw pressing of dehulled sesame seed is not feasible in view of the high oil content and the friable nature of the material and that solvent extraction alone is more efficient. Reports from the Central Food Technological Institute, Mysore, India, which recommends this procedure, indicate that no special difficulty is experienced in screw pressing dehulled seed, if carried out in two stages. The resulting cake contains 10% fat.

**Not to be considered as a requirement for producing satisfactory sesame flour.

Starting with raw material of the above quality, the yield of dehulled and dried seed (moisture 6 per cent) is about 82-84 per cent. The dehulled material should be a uniform white or dull white in appearance and possess the characteristic flavor of sesame. The dehulled seeds are deoiled in a screw press (or by alternate solvent treatment) to recover a major portion of the oil and to yield a cake containing 12-20 per cent oil. This presscake is extracted with food-grade hexane to recover the residual oil and the defatted meal is desolventized, dried and ground to obtain the edible sesame flour. The flour is screened and/or air-classified to obtain a fine fraction of protein content higher than the defatted meal. Specifications for the whole defatted edible sesame flour as well as the screened fine fraction are indicated below.

3. Recommended chemical composition (10-12)

	Defatted edible flour, whole	Defatted edible flour, screened/air-classified
Moisture, % by wt, max	9.0	9.0
Fat (dry basis), % by wt, max	1.5	1.5
Free fatty acids, % of residual oil, max	4.0	4.0
Protein (dry basis), N x 6.25, min	50.0	60.0
Total ash (dry basis), % by wt, max	6.2*	6.2*
Available lysine (g/16gN), min	2.4	2.4
Oxalic acid (dry basis), % by wt, max	0.50	0.50
Crude fiber (dry basis), % by wt, max	6.0	5.0

4. Recommendations on other characteristics

4.1 Physical characteristics

Particles	no coarse or gritty particles
Color	white or dull white

4.2 Organoleptic characteristics

Odor and flavor	free from mustiness, solvent or other unpleasant odors and with the characteristic mild pleasant flavor of sesame
Texture	smooth on the tongue

4.3 Sanitary considerations

Microbiological (refer to PAG Guideline No. 11)

4.4 Insect and rodent contamination

Free of insects, insect fragments, rodent hair and excreta

4.5 Extraneous mineral matter such as sand and dirt

Acid-insoluble ash (dry basis), %	less than 0.15

4.6 Nutritional considerations. Sesame proteins are rich in methionine, cystine and tryptophan, and experimental results indicate that the availability of methionine increases with heat (13). However, these proteins are deficient in lysine, which limits their nutritive quality. The lysine content of sesame protein is in the range of 2.5 - 3.0 g per 16gN and any drastic processing (particularly excessive heating) will adversely affect the available lysine. It is desirable to maintain a minimum level of 2.4 g of available lysine per 16gN. Such a flour gives a PER value of about 1.6 - 1.7, as compared to 3.0 for skim milk powder, when assayed with rats at a 10% protein level.

4.7 Toxicological considerations

4.7.1 Aflatoxin. Few systematic surveys have

* These values have been questioned by some specialists who point out reports in the literature indicating that defatted sesame products of this type usually contain total ash in the range of 11 to 12%.

been carried out on the incidence of aflatoxin in sesame seed. However, in conformity with the levels of aflatoxin prescribed for peanut, cottonseed and soy flours, a maximum limit of 30 mcg/kg (30 ppb) in the final product is considered acceptable (PAG Statement No. 2).

4.7.2 Selenium. This element may be present in significant amounts in food plants grown in seleniferous soils and protein-rich foods are especially prone to accumulate it (14). Although not much is known about the toxic level of selenium for humans, a maximum level of 300 mcg/kg (300 ppb) stated in the Latin-American Food Code (14) may be useful for defatted sesame flour.

5. Handling, storage and packaging

Sesame flour may be packaged in materials such as multiwall kraft paper bags with polyethylene or similar liners, polyethylene-lined jute (gunny) or cloth bags or tins. The packages should be strong enough to withstand normal handling during storage and shipment. Storage conditions should be such that the direct effects of heat and moisture are avoided. Adequate conditions must be provided to prevent infestation, rodent attack and contamination of the product.

6. Discussion

The main deterrent to the use of sesame seed and meal in foods is the presence of the fibrous hull fraction which contributes dark color, bitterness and oxalates. Dehulling of the seed is therefore essential for preparing an edible product. Low levels of oxalic acid (0.25 - 0.50 per cent) and acid-insoluble ash (0.1 - 0.15 per cent) in the final edible flour indicate that the decortication is satisfactory. Although direct solvent extraction of the flaked whole seed followed by sieving or air-classification of the meal has been suggested as a method for upgrading the quality of the flour (9), this approach may not be acceptable in areas where the raw, screw-pressed oil is highly valued for its flavor characteristics.

The presence of some gastrointestinal irritant factors in sesame flour has been reported in studies with premature infants (15). It is possible that the coarse fibrous fractions still present in the whole defatted flour may cause some adverse effects in infants. This fraction can be largely eliminated by sieving or air-classification. Further testing of edible sesame flours in infant feeding to clarify these adverse factors is necessary.

From the point of view of protein nutritional quality, sesame is deficient in lysine but high in sulfur-containing amino acids. Its optimum use would therefore be in food mixtures adequate in lysine but which would benefit from the additional cystine or methionine which sesame products provide. In order to upgrade the nutritional quality of the flour alone to a level comparable to that of milk protein, the flour may be fortified with optimal levels of lysine (1.25 g L-lysine. HCL/100 g flour) (16, 17).

References

1. Krishnamurthy, K., P. K. Tasker, T. N. Ramakrishnan, R. Rajagopalan, and M. Swaminathan. 1960. Ann. Biochem. Exp. Med. 20:73.

2. Hortvilleur, G. 1953. U.S. 2,815,783; CA 52: 4217 (1958).

3. Lucide, I.E. 1956. U.S. 3,054,433.

4. Appu Rao, B., M. R. Surendranath, M. Alla Baksh, and Thirumala Rao. 1964. S.D. Oil Mill Gazetteer 68.

5. Shamanthaka Sastry, M.C., N. Subramanian, and R. Rajagopalan, 1969. J. Am. Oil Chemists' Soc. 46:592A.

6. Ramachandra, B. S., M.C. Shamanthaka Sastry, and L. S. Subba Rao. 1970. J. Food Sci. Technol. 7:127.

7. Deschamps, I., R. Calderon, and A. Gonzalez. 1967. Proc. International Symposium on Protein Foods and Concentrates, Mysore, India.

8. Protein Advisory Group of the United Nations System. 1972. PAG Statement No. 21: Specifications for solvents. United Nations,

New York 10017, U.S.A.

9. Carter, F. L., V.O. Cirino, and L. E. Allen. 1961. J. Am. Oil Chemists' Soc. 38: 148.

10. Association of Official Agricultural Chemists. 1960. Official methods of analysis. Ninth ed. AOAC, Washington, D.C., U.S.A.

11. Carpenter, K. J. 1960. Biochem. J. 77:604.

12. Baker, C. J. R. 1952. Analyst 77:340.

13. Villegas et al. 1968. Cereal Chem. 45:379.

14. Jaffe, W. G. 1968. In The safety of foods. Proc. International Symposium on the Safety and Importance of Foods in the Western Hemisphere, University of Puerto Rico. AVI, Westport, Conn., U.S.A.

15. Snyderman, S. E., A. Boyer, and L. E. Holt, Jr. 1961. NAS-NRC Pubn. 843.

16. Subramanian, N. and M. C. Shamanthaka Sastry. 1970. Proc. Symposium on Food Science and Nutritional Diseases in the Middle East. Shiraz, Iran.

17. Joseph, A. A., P. K. Tasker, K. Joseph, M. Narayana Rao, M. Swaminathan, A. N. Sankaran, A. Sreenivasan, and V. Subrahmanyan. 1962. Ann. Biochem. Exp. Med. 22: 113.

PAG GUIDELINE (No. 13) FOR THE PREPARATION OF MILK SUBSTITUTES OF VEGETABLE ORIGIN AND TONED MILK CONTAINING VEGETABLE PROTEIN*

1. Objective

In many countries there is a severe shortage of animal milk, a popular and acceptable but expensive food. Good possibilities exist for expanding the available milk supplies by developing milk-like products from vegetable proteins such as milk substitutes (1) and vegetable-toned milk, i.e. milk extended with vegetable protein (2). If these products are prepared as nutritious and acceptable beverages or in other forms, they could supplement the available animal milk supplies in these countries and help meet the nutritional and culinary needs of the people. Considerable research and development has been done in different parts of the world on milk substitutes and vegetable-toned milk using peanuts and soybeans.

2. Description of products

Milk substitutes and milk extended with vegetable proteins may be in fluid or in dehydrated form. The sterilized fluid product is in ready-to-use form and may be distributed through all normal milk distribution channels. The dehydrated powdered product, packed under sterile conditions, has a longer shelf-life and can be transported over long distances. The product must be reconstituted with boiled water before use.

3. Scope

The products described are intended to serve as substitutes for animal milk, to be used as beverages, for preparation of other edible milk products and for use in culinary preparation where milk is ordinarily used. The products should serve merely as dietary supplements and not as exclusive or complete foods for children. They are not substitutes for breast milk and therefore cannot be recommended for feeding young infants under six months of age.

* Issued 13 June 1972.

4. Raw materials

a) Suitable protein products include edible defatted or full-fat soy flour (PAG Guideline No. 5), soy protein concentrates and isolates (3) (the isolate should be easily dispersible in water at pH6); also peanut flour prepared according to PAG Guideline No. 2 or peanut protein concentrate or isolate (4) (the isolate should be easily dispersible in water at pH5). Protein concentrates and isolates properly prepared from other oilseeds and legumes may also be used in the preparation of milk substitutes. However, individual processes and specifications will have to be worked out following the same principles which have been developed and used for peanut and soybean products.

b) Whole milk in liquid form or as dry powder should be used along with materials listed in a) above in the preparation of toned milk containing vegetable protein.

c) Carbohydrates (sucrose, invert sugar, liquid glucose and/or hydrolyzed starch of various dextrose equivalents), which should be of food-grade quality.

d) The products should be supplemented with vitamins and minerals to levels conforming with approved standards. It may also be necessary to add one or more of the limiting essential amino acids so that the protein value of the product will approximate that of cow's milk.

e) Vegetable oil containing not less than 2% essential fatty acids expressed as linoleic acid. It is recommended that a mixture of hydrogenated and refined vegetable oils be used for milk substitutes from peanuts. Milk fat may be one of the fats in the mixture, as in the case of toned milk. The addition of an edible emulsifier is recommended to obtain emulsion stability of the product and help in reconstitution of dehydrated products.

f) In accordance with FAO/WHO recommendations (5) for foods to be consumed by young children, special care must be taken in the addition of any flavoring or coloring material; only flavors or other additives approved for food use may be employed.

5. Procedure

5.1 Plant and equipment

All items of equipment should be made from noncorrodible material, preferably stainless steel or glasslined vessels, and must satisfy sanitary standards as prescribed for dairy plants. Processing techniques should conform to good food manufacturing practice.

5.2 Preparation

5.2.1 Milk substitutes based on soybeans. The improved hot-water process minimizes the development of beany off-flavor and may be followed for the preparation of soybean milk (1, 6, 7). The process consists of the following steps:

a) soaking whole soybeans in water at 40-45°C for one hour;

b) grinding the soaked beans in boiling water in the proportion of nine parts water per one part dry beans (w/w);

c) Filtration and addition of carbohydrates (see 4c above), buffer salts (sodium and potassium phosphates), minerals (calcium and iron salts) and vitamin premix;

d) boiling for 60 minutes or sterilization in sealed bottles at 121°C for 15 minutes to destroy trypsin inhibitors, hemagglutinins and bacteria. The product can be spray-dried at step c) before addition of carbohydrates, vitamins, etc., if a dehydrated product is required.

Other suitable processes for soy milk production have been proposed, reference to which may be found by consulting the food technology literature.

5.2.2 Milk substitute based on peanuts or on a blend of peanuts and soybeans. The process consists of the following steps:

a) extraction of protein from peanut flour by dilute alkali;

b) precipitation of protein from the protein liquor by the addition of acid to the isoelectric point;

c) recovery and dispersion of the protein isolate in water by addition of alkali and buffer salts at pH 6.8;

d) addition of carbohydrates (sucrose or malt sugar-dextrin) and a mixture of hydrogenated and refined vegetable oils;

e) addition of minerals and vitamins;

f) sterilization;

g) homogenization (sterilization before homogenization results in a more stable emulsion);

h) bottling.

To increase the nutritive value of the protein, the milk substitute from peanuts can be blended with a milk substitute from soybeans before sterilization and packaging.

5.2.3 Toned milk containing peanut and/or soybean protein.

The process consists of the following steps (8):

a) extraction of protein from peanut flour or soybean flour by dilute alkali;

b) precipitation of protein from the protein liquor at the isoelectric point;*

c) dispersion of the protein isolate in water by addition of alkali and buffer salts and adjustment of pH to 6.8;

d) addition of carbohydrates (sucrose, liquid glucose or enzyme-hydrolyzed starch) and fats (a mixture of hydrogenated and refined vegetable oils);

e) addition of minerals and vitamins;

f) blending with fresh animal milk;

g) sterilization;

h) homogenization;

i) bottling and packaging.

Rapid advances in the technology of vegetable milk production are taking place and new and more efficient processes, using a variety of raw materials, are being developed. This guideline will be reviewd as and when these techniques are published and experience in their use becomes available.

6. Recommended chemical composition (9, 10)

6.1 Milk substitute

	Fluid, sterilized	Dry
Moisture, %, max	89.0	3.5
Fat, %, min	2.0	18.0
Nonfat solids, %, min	9.0	78.5
Protein (Nx6.25), %, min	3.5	28.0
Essential fatty acid content, expressed as linoleic acid as per cent of weight of fat, min	2.0	2.0
Carbohydrates (sucrose or malt sugar-dextrin), %	4.0 min	51.5 max
Calcium, mg/100 ml or 100g, min	100	800
Vitamin A, mcg/100 ml or 100g, min	50	450
Vitamin D, I.U./100 ml or 100g, min	40	360
Iron, mg/100 ml or 100g, min	0.4	4.0
Thiamine, mg/100 ml or 100g, min	0.15	1.0
Riboflavin, mg/100 ml or 100g, min	0.15	1.3
Niacin, mg/100 ml or 100g, min	1.0	8.0
Folic acid, mcg/100 ml or 100g, min	5	50.0

*Steps a) and b) can be avoided if dried peanut or soybean protein isolate is available.

Pathothenic acid, mcg/ 100 ml or 100g, min	200	1600
Vitamin B_{12}, mcg/100 ml or 100g, min	0.5	5.0
Pyridoxine, mcg/100 ml or 100g, min	200	1600
Ascorbic acid, mg/100 ml or 100g, min	3.0	25.0
Total ash, max		7.0
Acid-insoluble ash, max		0.05

6.2 Toned milk containing vegetable protein

	Fluid, sterilized	Dry
Moisture, %, max	89	3.5
Fat, %, min	2	18.0
Nonfat solids, %, min	9	78.5
Carbohydrates (lactose/ sucrose and malt sugar-dextrin), %	4.0 min; 8.0 max	35.0 min (lactose, 12.0 min)
Protein (Nx6.25), %, min	3.5	20.0
Essential fatty acid content, expressed as linoleic acid as per cent of fat, min	2.0	2.0
Total ash, max		7.0
Acid-insoluble ash, max		0.05

The recommended levels of vitamins and minerals are the same as those indicated for the milk substitute (para 6.1).

7. Recommendations on other characteristics

7.1 Physical characteristics

Color (without added colors): cream or slightly grayish

Insoluble constituents: nil

7.2 Organoleptic characteristics

Milk-like odor and taste or that of added flavors.

7.3 Sanitary considerations

Microbiological (refer to PAG Guideline No. 11).

For sterilized milk, the pH change on seven days incubation at 55°C should not exceed 0.3.

Variation in titratable acidity expressed as lactic acid on seven days incubation, 0.02 max.

7.4 Insect and rodent contamination for dry product

Completely free of insects, insect fragments, rodent hair, rodent excreta and any other extraneous matter.

7.5 Toxicological considerations

Because of the possibility of contamination of peanuts with aflatoxin, an assay should be conducted on the products prepared from peanut. The level of aflatoxin should not exceed 30ppb on a dry basis (PAG Statement No. 2). The soy-based products should be substantially free from antibiological factors (e.g. antitrypsin and hemagglutinins) as defined in PAG Guideline No. 5.

7.6 Available lysine

The available lysine in these products before consumption should not be less than the figures given below.

	Available lysine (g/16N)
Milk substitute based on soybean	5.0
Milk substitute based on peanut	2.5
Milk substitute based on peanut and soybean (1:1)	3.8
Toned milk containing peanut protein	3.5
Toned milk containing soybean protein	5.0

8. Control of heat processing for inactivating trypsin inhibitor

In the preparation of milk substitutes, heat processing conditions should be such that the

trypsin inhibitors originally present in the raw material are almost completely inactivated. Determination of urease activity (10) provides an indirect indication of the degree of inactivation of antinutritive factors such as trypsin inhibitors (PAG Guideline No. 5). An increase in pH of 0.3 or less would indicate presumptively that the product retains slight urease activity but has received sufficient heat treatment for inactivation of antinutritive factors and for improvement of the protein quality. Milk substitutes based on soybeans or blends of soybeans and peanuts showing an increase in pH greater than 0.3 should be considered to have received insufficient heat treatment to inactivate the inhibitors.

9. Some precautions and warnings.

Since facilities for refrigeration are not always available in developing countries, the use of pasteurized fluid milk is not recommended. If vegetable milk substitutes are to be used as pasteurized fluid milk, they should be stored at all times at refrigerating temperatures (4-6°C) and used up in less than 72 hours after manufacture or even earlier. The bottles or other containers (plastics or paper) should meet requirements for bottling practice in dairies. The bottles will be suitably foil-capped and the contents distinguishable from pasteurized cow's milk by using different types of bottles or color designs on the foil caps. In all marketing literature, advertisement boards, etc., the nature and composition of the products should be clearly described. The sterilized product can be stored in hermetically sealed containers with little or no quality change. Measures must be taken during sterilization to avoid damage to protein quality.

The spray-dried products should be packed in suitable containers to provide against uptake of moisture and oxidation of fat and to ensure keeping quality for a period of nine months. The package should be suitably labeled to provide the consumer correct information on the date of manufacture and the nature of the product.

References

1. Hand, D.B., K.H. Steinkraus, J.P. Van Buren, L.R. Hackler, I. el Ravoi, and H.R. Pallesen. 1964. Pilot plant studies on soybean milk. Food Technol. 18:139.

2. Chandrasekhara, M.R. 1968. Extension of milk resources with vegetable proteins. Indian Food Packer XXII, No. 3:1.

3. Circle, S., P. Julian, and R. Whitnery. 1959. An improved process for the isolation of soy protein. U.S. 2,881, 159.

4. Bhatia, D.S., H.A.B. Parpia, and B.P. Baliga. 1966. Peanut protein isolate - production and properties. J. Food Sci. Technol. 1:2.

5. FAO/WHO. 1967. Seventh Report of the Joint FAO/WHO Expert Committee on Nutrition. FAO Nutrition Report Series No. 42; WHO Technical Report Series No. 377.

6. Wilkens, W. F., L.R. Mallick, and D.B. Hand. 1967. Effect of processing method on oxidative off-flavors of soybean milk. Food Technol. 21: 1630.

7. Wilkens, W.F. and L.R. Hackler. 1969. Effect of processing conditions on composition of soymilk. Cereal Chem. 46:391.

8. Chandrasekhara, M.R., B.R. Ramanna, K.S. Jagannath, and P.K. Ramanathan. 1971. Miltone-vegetable toned milk. Food Technol. 25, No. 6:32.

9. American Association of Cereal Chemists. 1968. Cereal laboratory methods. 7th edition, revised. AACC, St. Paul, Minn., U.S.A.

10. American Oil Chemists' Society. 1968. Official and tentative methods. 3rd edition. AOCS, Chicago, Ill. U.S.A.

COMMERCIAL PRODUCTION OF LEAF PROTEIN FOR ANIMAL AND HUMAN USE*

by E. M. Bickoff and G. O. Kohler

Western Regional Research Laboratory, Agricultural Research Service

U.S. Department of Agriculture, Berkeley, Calif., U.S.A.

Although leaf protein has been known for many years to have nutritional value, until recently it has been more of a laboratory curiosity than an article of commerce. Initial commercialization has depended upon the availability of a process yielding high-value dehydrated alfalfa as well as a leaf protein product for use in animal rations. The logistics for handling large amounts of bulky plant materials had already been worked out and a market for dehydrated alfalfa exists in many parts of the world. It is felt that leaf protein concentrate (LPC) for human food should also be developed initially within the framework of existing commercial alfalfa-processing operations. Some companies produce as much as 250,000 tons of dehydrated alfalfa meal per year. In the absence of sponsorship by governments, or international agencies, only large companies have the capital to finance the research and development necessary to put the process for edible protein into commercial operation.

This has been the philosophy in developing the PRO-XAN process (the name is derived from "protein xanthophyll concentrate"). Phase I (now commercialized) produces a) standard-grade dehydrated alfalfa meal; b) a 50% protein, high-xanthophyll concentrate for poultry called X-PRO** and c) a forage solubles concentrate for use as an unidentified growth factor (UGF) supplement for livestock. Phase II of the program is involved with the development of further economically sound steps to yield pigment-free, palatable LPC plus xanthophyll concentrate from the intermediate or end products.

Commercialization of Phase I has been carried out through the cooperative efforts of the Western Regional Research Laboratory and a large commercial dehydrator in southern California. This company normally harvests and processes about 300,000 tons of alfalfa per year to produce about 60,000 tons of dehydrated meal for poultry and cattle. By incorporating the Phase I process into their normal operation they are producing several thousand tons of a 50% protein-high xanthophyll leaf protein concentrate (LPC) which is sold as a feed supplement for poultry in addition to the dehydrated alfalfa.

Because the PRO-XAN process employs a "scalping operation" to remove only a small amount of the protein, the residual alfalfa meal still contains sufficient protein so that it can be sold in normal commercial channels as a feed ingredient without discount from normal prices. This combined commercial operation is now in its third year and has proven to be sufficiently profitable that the company is contemplating a further expansion of the operation. The success of the operation can to a large extent be attributed to the employment of standard sugarcane rolls to both crush and express the juice very rapidly in one low-maintenance operation, and to the employment of commercially-available drying units already familiar to the dehydration industry. In addition, the process is set up as a continuous operation and is completely automated.

Phase I of the program is considered essentially complete, and Phase II, a research program, is in progress for further development of economically sound steps to yield pigment-free, palatable leaf protein concentrate in addition to the three products now being produced. The successful development of Phase I of the PRO-XAN process has

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*Submitted as a background paper for the 20th PAG Meeting. PAG Document 2.30/3.

**Trademark for protein-xanthophyll concentrate.

prompted interest in the development of Phase II by numerous alfalfa dehydrators throughout the world. At present, two large alfalfa processors, one in America and one in Europe, are involved in pilot-plant development of Phase II of the PRO-XAN process.

The forage dehydration industry sells its normal products, largely 17-20% protein alfalfa, at a retail price of $US 50-60 ton FOB plant or 12-15 cents/lb of protein assuming no other value recovered. These prices include profits to the farmers and processors. The raw material, fresh forage in the field, sells for $10-20/dry ton or 2.5-5 cents/lb of protein. Thus fresh alfalfa provides a very low-cost raw material for protein recovery. When the returns from all the products are considered, it is felt that previously quoted figures of 10 to 20 cents per pound* for the crude protein product will be found to be unduly high. These earlier figures do not give proper weight to the returns from the various animal feed products, the dehydrated meal, the high-protein poultry feed supplement and the molasses-like solubles concentrate.

Alfalfa and other forage plants are among the world's largest renewable supplies of protein for animal agriculture. According to the FAO Yearbook, there are over 6.5 billion acres of meadows and permanent pastures in the world. In the United States alone, over 130 million tons of grass and legume hays are produced annually, of which 74 million tons is alfalfa hay.

Of the 20 major crops alfalfa produces the highest yield per acre of the essential amino acids. From a nutritional standpoint, it has been shown that the amino acids of alfalfa are well balanced and at least equivalent to those of soy protein. In recent feeding tests at the Western Regional Research Laboratory, the LPC preparations have been found to be almost 100% digestible and superior to casein in protein quality. With the animal feed products carrying a large portion of the cost of the processing, it is felt that a low-cost, edible LPC can be produced from alfalfa. The product, when perfected, will be bland-tasting, white in color, and stable during storage. Such a protein preparation will contain more than 90% protein and will be competitive with other sources of food protein.

With proper utilization of alfalfa protein there need be no food protein deficit in the world. Considering the world population as 3.2 billion and an average need for 35 grams of protein per person per day as recommended by FAO, it has been calculated that enough alfalfa protein to meet the needs of the entire world population could be produced on an area approximately the size of Texas. Sufficient protein would remain in the alfalfa residue to be either dehydrated or ensiled and fed to cows to produce additional milk and meat.

THE TECHNICAL ADVISORY COMMITTEE (TAC) OF THE CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

by P. A. Oram, FAO, Secretary of TAC

The following is a summary of the discussions relevant to protein production held at the first, second and third meetings of TAC. The first and second meetings were held in 1971 and the third in the first half of 1972. A brief outline on the establishment of the Consultative Group on International Agricultural Research and TAC is given in a paper by Mr. Harold Graves

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* PAG Statement No. 11 on Leaf Protein Concentrate (11 June 1970).

in PAG Bulletin Vol. II, No. 3, 1972.

Reports on the programs of the four international research centers and from France, the United Kingdom, U.S.A., OAS (Organization of American States) and FAO concerning their current research activities in developing countries were available for consideration by TAC. The Committee was able to review in detail the following topics: agricultural research involving rainfed crops such as millet and sorghum; the need to strengthen research on food legumes as a whole; research on animal health and production in tropical Africa; rice development in West Africa; potato improvement in Latin America; vegetable production in the Far East; improvement in systems of agriculture in semiarid and arid areas; multiple cropping in areas with adequate rainfall or irrigation; progressive erosion of natural genetic resources resulting from environmental causes; integrated pest control and improvement in the methods of communication in agricultural research.

The efforts of the International Wheat and Maize Improvement Center (CIMMYT) in Mexico to increase the yield and consumer acceptability of the high-lysine and high-tryptophan maize varieties were noted. However, it has proved difficult so far to combine high yield with acceptable appearance and quality of grain. Similar genetic linkages for high-lysine wheat have not been identified. Total protein content appears to be a heritable trait, but protein content and lysine level are generally negatively correlated. Programs to raise wheat yields both of durum and of bread wheats have achieved significant results and it is expected that increasing attention will be given to quality in the future.

CIMMYT also has a small program related to the development of triticale, a hybrid of wheat and rye which appears to have the stability to be developed into a new "man-made" cereal species. This has a higher protein content and better protein quality than wheat. While it is not expected to have immediate application in human nutrition, triticale offers interesting possibilities for livestock feed.

The International Rice Research Institute (IRRI) in the Philippines works largely on rice with attention focused on increasing yields, varietal improvement and increasing protein content. The increase in protein content from around 8 to 10% which, although small, appears feasible, would make a significant contribution to dietary protein.

Apart from its rice program, the Institute has also been supporting a small but highly encouraging research effort on multiple cropping. This involves an extremely intensive rotation including both cereals and other crops, with emphasis on food legumes (soybeans and mung beans where short-maturing varieties are available) and on sweet potatoes, which are probably the most nutritious of the tropical tubers. Very high annual yields of dry matter of the order of 20 tons/hectare have been achieved in this program, but perhaps even more important is the well-balanced diet which could result from the wider use of such practices by farmers. There is also a considerable output of by-products, e.g. sweet potato, legumes, and hay, useful for incorporating livestock into the system.

The International Center for Tropical Agriculture (CIAT) in Colombia is engaged in testing improved varieties of maize and rice developed by or sent to them from other international centers concentrating specifically on these crops. It also has programs of its own in relation to food legumes (Phaseolus) and soybeans and cassava, both for human consumption and in a swine production program. The latter also uses other locally-available products, e.g. opaque-2 maize and banana, in its feeding scheme. There is major emphasis on beef production, which accounts for nearly 30 per cent of its core budget. This program is concentrating mainly on developing new beef production systems for family farming in the underpopulated latosol areas of Latin America and also in the humid coastal plains. In both of these regions attention is being concentrated on pasture and fodder production, husbandry methods and animal health problems, particularly blood parasites and early calf losses.

The International Institute for Tropical Agriculture (IITA) in Nigeria is devoted to research on the problems of the humid tropical zone

below 600 meters in altitude where precipitation exceeds evaporation for more than half the year. It is the newest of the four institutes, and the program in its formative stages covers: research on agricultural systems in respect to the humid tropics with particular reference to finding alternatives to shifting cultivation; worldwide responsibilities for research on cowpeas and possibly on other appropriate grain legumes and on yams and sweet potatoes; and cooperative research with other institutes on the African continent, on maize with CIMMYT, rice with IRRI, and cassava with CIAT.

The International Centre for Research in the Semi-Arid Tropics (ICRISAT) being established in India is expected to study means of raising yields and quality of sorghum and millet, the two main cereals of this ecological zone, and certain food legumes, notably cicer (chickpeas) and cajanus (pigeon peas). It is also proposed to link the activities of this center to work in progress in Africa and other regions with similar ecological conditions.

A proposed new International Laboratory for Research on Animal Diseases (ILRAD) in Africa will focus its work on immunology and development of vaccines against trypanosomiasis and East Coast fever. This is seen as part of a wider integrated research program aimed at increased productivity of ruminant livestock and wider exploitation of land for agriculture and especially for cattle. As the logical form of land use and main source of income and employment in most of the savannah belt of Africa, as well as making a significant contribution to improvement of the diet, livestock development in Africa has great social and economic importance and a team is now in the field with the task of preparing a comprehensive research program for livestock development.

The TAC has also recommended support for the International Potato Center (CIP) in Peru. The main aims of this center are to increase the range of adaptability of the potato, with particular emphasis on making it more widely available in the humid tropics, and secondly to raise the protein content by plant breeding. The achievement of either of these objectives would offer significant improvements in the diet, in the first case by making feasible the substitution of potato for less nutritious starchy products such as cassava, and in the second by raising protein intakes in existing areas of potato consumption at no extra cost.

With regard to legume research, the approach should be toward increasing the yield and improving the protein quality of food legumes. Some of the basic research required includes factors affecting photosynthetic efficiency, indeterminant flowering habit and loss of flowers and fruits before maturity, symbiotic relationships with rhizobia, biosynthesis of amino acids and proteins, and factors affecting protein, carbohydrate and oil distribution in the different parts of the seed. The critical problem is the low yield and apparent unresponsiveness of the food legumes to production inputs such as water and fertilizer, which render them increasingly less competitive with high-yielding cereals. However, while common problems might benefit from centralized research, the number of crops involved and their highly ecospecific nature require regional decentralization of applied aspects of needed research.

It was noted that some of the research input from existing international centers will be of benefit to the Mediterranean and Near East region. However, certain of the important crops there, e.g. barley, grain legumes such as lentils and broad beans (Vicia faba), and annual oilseeds such as sesame, were not covered by major breeding programs at any institute in the developing countries. In addition, a high proportion of the region, even in irrigated areas, is fallow every year. There is a strong case for believing that this land could be used more effectively, particularly for the production of fodder crops linked to livestock development. Although the ecological conditions are similar to Australia, and the Australian system of wheat/sheep production depends largely on pasture species imported from the Mediterranean and the Near East, research is needed to discover why a similar close integration of crops and livestock has not been achieved in this region, as well as to raise the yields and improve the protein content of the staple food crops. For example, high-

lysine varieties of barley have been discovered in this region but are not grown commercially there. The TAC considered that this was an important problem, but that further definition was needed of the priorities and approaches, and it is fielding a mission to undertake this study in February 1973.

The need for the establishment of an international network of genetic resource centers linking both developed and developing countries and international institutes was stressed. This would ensure the preservation for future use in agricultural development of the range of wild species and primitive cultivars which provide the main reserve of variability for crop improvement. High priority in such a program would be given to food legumes. The proposal for setting up an Asian Vegetable Research Center in Taiwan and the subject of aquaculture were also briefly discussed.

It will be observed from the above that the Committee rightly gave emphasis and priority to research for raising yield and quality of food crops and livestock. The programs of the international research centers have a major contribution to make to the solution of the protein problem. International support for research must, of course, be complemented by adequate national programs and while international research centers do put considerable emphasis on training and "outreach" assistance to national programs, this is a field in which FAO, IBRD and UNDP must also play an important role. A problem which faces both the TAC and the Consultative Group is the volume of requests coming in which is likely to exceed considerably the resources available. Nevertheless, it is reasonably certain that food production, and in particular the quality of the diet, will be accorded very high priority in any strategy which is recommended.

SINGLE - CELL PROTEIN : WHICH ONE DO YOU MEAN ?*

In 1966 the term "Single-cell protein" (SCP) was coined at the Massachusetts Institute of Technology (1). It was intended to describe and embrace a wide variety of yeasts, bacteria, fungi and algae in which considerable interest had developed as potential food or feed ingredients. One might argue that "Single-cell protein" is a slightly misleading term since all protein is cellular in origin and not all single-cell proteins are in fact monocellular, but the term is now widely accepted and used to describe micro-organisms of the types mentioned.

Unfortunately, however, when one term is applied to a variety of products there is a danger that the properties of individual ones may be submerged in generalised observations. This, in turn, can lead to errors in attempting to deduce the characteristics of a specific product from a general description of the properties of single-cell proteins. The result could be that a "folklore" grows up around these products that ultimately comes to be accepted as unquestionably true whereas it may be distinctly the reverse in individual cases.

The two areas in which interest lies as regards these materials are those of safety and nutritional value and it is in these areas that it is important to avoid misconceptions when particular products are being considered.

To say that SCPs are toxic is as erroneous as to say that they are not. There are examples of both to be found in all the categories mentioned. Poisonous fungi exist alongside the edible mushroom; there are toxic and non-toxic strains of Aspergillus and Penicillium. Both toxic and non-toxic yeasts and bacteria are known as are different species of algae.

*Reprinted from the British Nutrition Foundation Bulletin No. 7, 1972.

Paradoxically, the toxicity aspect may be less important than the nutritional aspects of those single-cell proteins which will find their way into food or feed materials since, undoubtedly, any reputable producer and any responsible governmental authority will require convincing proof of the safety of these products before permitting their use for either animals or man. One is entitled to assume and one may be assured that whatever SCP is used for these purposes will, at least, be non-toxic and will have been shown to be so by the most stringent tests yet devised for this purpose. The SCP Working Party of the Protein Advisory Group of WHO/FAO/UNICEF has issued two documents under the titles of PAG Guidelines Nos. 6 and 7 dealing with the procedures to be followed in establishing the safety and suitability for use of such materials.

It is in considering the nutritional characteristics of SCP that generalisations are apt to be most misleading; they are most evident with regard to digestibility and nucleic acid content of the material. There have been statements that SCP is of low nutritional value because of the indigestibility of the cell walls. In certain cases this may well be true. Oswald & Golueke (1) comment upon the low availability of nutrients in algae and state that "most of the problem with availability seems related to the durable cell wall".

On the other hand, work at the Instituut voor Lanbouwkundig Onderzoek van Biochemische Produkten in Wageningen, Holland has shown that the percentage digestibility of the organic matter in yeast produced by the BP process in Scotland is 80% for chicks of 3-5 weeks of age and 92% for pigs between 30 and 60 kg in weight. Similar results for chicks on the BP yeast produced in France have been published (2). Barber et al (3), referring to the yeast produced on pure n-paraffins, state that the availability of the amino acids in the yeast protein used in their experiment with pigs was exceptionally high as judged in microbiological tests, 90-95%, as against 80-85% availability commonly observed in their Institute for white fish meal. Lewis & Boorman reported results with chicks in agreement with these findings at the Society for Animal Production Congress at Versailles in July 1971. It is difficult to see how these high values for digestibility and amino acid availability could have been achieved had the utilisation of the products been inhibited by the presence of indigestible cell walls.

It is clear, therefore, that a comment which might, quite justifiably, be made about one SCP would be quite unjustified when applied to another.

The other major criticism of SCPs concerns their possibly high content of nucleic acids. To what extent is this true and how significant is it? In general the ribonucleic acid (RNA) content of SCP is much higher than that of the majority of other foods. The yeasts referred to above have an RNA content of about 8% and certain bacteria have been reported to contain up to 29% of RNA. This contrasts with levels of 2.6% for liver, 4.1% for fish roe and about 1% for white fish meal. However, the significance of these concentrations is quite different for man and the other primates on the one hand and for the rest of the mammals on the other.

The objection to an excessive dietary intake of nucleic acids is that the final metabolic product of the purines contained in them is, for the primates including man, uric acid. The immediate consequence is an elevation of serum and urine uric acid levels in these species. Some clinicians consider that this might result, over a long period, in the formation of kidney stones in some cases and that it would aggravate arthritic or gouty tendencies in certain others. Fortunately there are several methods available for reducing the RNA content of most SCPs and these would certainly be applied to those materials destined for consumption by humans. As an indication a reduction of the RNA content of the yeast previously referred to from 8% to 1%, a concentration which presents no metabolic problem, is not difficult.

Such considerations do not apply to the nutrition of mammals other than the primates since in such animals uric acid derived from the purine bases is degraded further by a

uricase to allantoin and urea, neither of which is suspected of causing any problems such as that caused by the more insoluble uric acid. Indeed in the ruminants nucleic acids could be used for the synthesis of microbial protein in the rumen.

To summarise, there are two commonly held beliefs about the nutritional characteristics of single-cell proteins. The first, concerning digestibility, is true for one SCP but may not be true for another. The second belief, concerning high nucleic acid content, is generally true but its significance is quite different according to the use that is made of the product. An awareness of these differences means that the manufacturers can ensure that SCP intended for human consumption will be appropriately treated.

Single-cell proteins, then: are they safe or toxic, digestible or indigestible, high or low in nucleic acid content? Well, of course, it depends on which SCP you mean.

References

1. Oswald, W.J. & Golueke, C.G. (1968). Single-Cell Proteins ed. Mateles, R.I. & Tannenbaum, S., p. 291. (MIT Press).

2. van Weerden, E.J., Shacklady, C.A. & van der Wal, P. (1970). Br. Poultry Science II, 189-95.

3. Barber, R.S., Braude, R., Mitchell, K.G. & Myres, A.W. (1971). Br. J. Nutr. 25, 285-294.

THE EFFICIENT USE OF WORLD PROTEIN SUPPLIES*

by John C. Abbott, FAO, Rome

The paper which follows was intended to provide an economic context for a specialist appraisal of various protein foods. The approach adopted is, first, to consider whether the world's protein resources are being used efficiently, and secondly whether new and unconventional protein foods are being introduced and marketed to the best advantage. As a first step, one may look at the factors governing the distribution of protein resources under existing conditions, then consider the various measures that are being taken to modify their distribution according to nutritionally desirable criteria.

To keep this review in a dynamic frame the recent FAO commodity projections to 1980 (1) are examined for new elements of potential significance.

Economics of food distribution

The production and marketing of protein are undertaken not only because techniques have been developed and are available, but to meet evident market demands. World demand for protein is unsatisfied at present prices, and it will expand rapidly over the next 20 years from population increase alone, without allowing for any rise in per caput income in the developing countries. But how far is this nutritional demand likely to be effective in economic terms, and how large a share of it will go to new forms of food protein? It is

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likely that the additional population will adopt the tastes and habits of the previous generation unless these become too costly, or unless specific initiatives are taken to change them. The openings for new food proteins are conditioned, therefore, by the likelihood of existing protein consumption trends being modified by significant changes in price relationships, and/or success in introducing and marketing new competing foods on the basis of their consumer appeal.

Effective demand, i.e., demand that is supported by disposable income and willingness to use it on protein food purchases, is at present directed almost entirely toward the traditional foods. Animal protein foods are preferred by most consumers: demand is limited by price at the current consumer income/production cost equilibrium. Thus the main demand change since before the second world war has been the shift of preference from grains and pulses to animal protein sources in wealthier countries. Animal protein consumption has risen sharply in Japan, for example, in reflection of expanding consumer income, and demand for traditional soy products has fallen back.

In recent years widening interest in weight control and concern over cholesterol intake have borne significantly on demand responses to rising income and there has been a shift away from eggs and milk in North America and in the wealthier parts of Europe. The very high meat consumption levels in Argentina and, to a lesser extent, in Australia have also fallen away somewhat with income/cost relationships probably the main factor.

Consumers in low-income countries have a great desire for animal protein, but few can afford it. Average per caput expenditure on food in India has been estimated at U.S. \$36.00 per year - about 10 cents a day - out of a total income of \$63.00 (2). This estimate includes an allowance for home-produced foods. For the mass of the people in India there can have been little change to date. Unskilled workers there still earn only two to three rupees per day. Sixty percent of their expenditure is taken up by basic cereals. Under such constraints, proteins are consumed mainly as a natural ingredient of the chief hunger satisfiers - cereals and pulses. The large absolute increases in population forthcoming in such countries will not in themselves affect the nature of the market for protein foods unless per caput income rises.

In the choice between alternative foods, cost is undoubtedly the main factor limiting demand for the population groups with inadequate diets. It is still important in the competitive servicing of higher-income markets and it remains at the forefront of any appraisal of alternative protein sources. The costs of widely consumed protein foods are compared in Table 1. They are based on 1970 or 1971 prices for average quality wholesale purchases at a major source of low cost supplies of each product. To allow, at least very roughly, for the value of the calories in each food these have been priced on a par with sugar as a near pure calorie food in wide international demand, and deducted. It is understood, of course, that costs calculated in this way reflect other attributes of these foods as much as protein content: beefsteak is not eaten for protein alone. Furthermore, import duties and restrictions, transport costs, distribution margins and so on can radically change inter-product cost relationships in a particular country. Account should also be taken of the biological value of the protein which is generally higher in foods of animal origin. Subject to such reservations it is striking how much lower in cost is protein from chick-peas, for example, than the protein in what are commonly regarded as protein foods.

Grains, the staple food in most countries, are also the main source of protein, furnishing almost half the total supply (3). This proportion ranges from 70 percent in Pakistan to 17 percent in the United States. In Argentina, Australia, New Zealand, Canada, the United States and most of northwestern Europe, however, the main source of protein is meat. In Ireland and Sweden dairy products are more important.

Pulses, oilseeds and nuts provide almost 13 percent of the world's protein supplies. Their contribution is as high as 28 percent in Brazil and probably of the same order in China. They provide 19 percent of the protein in Mexico and

Table 1. Relative Cost of Protein in Major Foods

	Price of product	Protein content	Price of protein[1]
	Cents per kg	Percent	Cents per kg
Chick-peas[2]	11	20	13
Wheat flour[3]	15	11	33
Beans[4]	20	22	53
Skim milk powder[5]	33	36	68
Fish, dried[6]	55	37	141
Cheese[7]	77	25	266
Chicken[8]	59	19	282
Pork[9]	40	10	325
Eggs[10]	51	11	430
Beef[11]	75	15	478
Lamb[12]	70	12	535

[1]Net of calorie contribution valued pro rata with sugar at 8 cents per kg. - [2]Banda, Uttar Pradesh, India 1971. - [3]Toronto, Canada, export price 1970. - [4]Dry, Mexico City 1971. - [5]New Zealand commercial exports July/September 1971. - [6]Dried and salted cod exports, Norway 1970. - [7]New Zealand white, London Provision Exchange 1971. - [8]U.S. ready-to-cook broilers, Chicago 1971. - [9]Average all weights, Chicago 1971. - [10]Netherlands export price 1970. - [11]Australia average first and second export quality 1971. - [12]New Zealand frozen carcasses, Smithfield, London 1971.

18 percent in India, but in most countries much less.

Fish, too, accounts for only about 3 percent on a world basis but catches are growing rapidly. It is the main source of animal protein in countries such as Ceylon, Japan, Ghana, the Philippines, Portugal and Taiwan. In Portugal fish supplies 18 percent of the total protein and in Japan, 17 percent.

Animal protein foods provide roughly 30 percent of the world's protein supply as against 70 percent from vegetable sources. Consumption of animal origin protein is closely linked with income - about 20 grammes per caput in the developed countries as against 3 to 4 grammes per caput in the developing world. Dried skim milk is the lowest priced animal protein and has an established market in India and elsewhere for reconstitution with local milk of high fat content as an acceptable "toned" product.

Patterns of market demand can, of course, be modified considerably by government action. Milk was made available to the whole population of the United Kingdom during the second world war by government subsidy. While it is recognized that the developing countries generally lack the means to subsidize consumption of particular foods on any substantial scale, it is appropriate to ask how far they are pursuing policies directed toward securing the highest nutritional dietary levels within their limited means. Most of their governments recognize that malnutrition can prejudice social and economic development significantly through deleterious effects on public health and productivity. While in many cases committing themselves to traditional public health programmes, including expenditure of hard currency upon imported drugs, often they find it difficult to implement other measures which would be helpful in reducing protein malnutrition. These include adjustment of agricultural plans and policies to favour food crops against those bringing immediate export earnings, and organizing supplementary distribution of protective foods to children in low-income groups.

Adequacy of protein distribution

With the acceptance of the new estimates of individual protein requirements forthcoming from the FAO/World Health Organization Expert Committee of April 1971, most countries with adequate calorie supplies appear to have more than enough protein on a national average per caput basis.

Income, food tradition, education and other factors which lead to wide divergencies in protein intake within a given population were examined in FAO's The state of food and agriculture 1964. Still more strategic than

before is the point that more protein food than needed to cover average requirements must be available if all the population is to get enough. Food consumption surveys demonstrate that, during seasonal food shortages, not only do these inequities in distribution become more acute but the number of families that are undernourished also increases. Per caput levels of consumption decline significantly with rising sizes of family, so there is a high statistical probability that children in large families are under-nourished. This is supported by specific information from surveys that the available food is very often distributed disproportionately among the various members of a family. The adults satisfy their needs at the expense of the children, who are inclined to eat more slowly. Yet, children's protein needs are proportionately greater than adults' because both maintenance and growth must be covered. Surveys carried out in Nigeria, Ghana, Central America, Colombia and a number of other countries showed that even where family supplies were satisfactory children were receiving only 70 to 80 percent of their requirements. This is confirmed by a study of Indian household data which showed that the addition of a child to the family is associated with relatively small increases in the consumption of animal and total proteins both in urban and rural areas. It is clear from the evidence available that the present distribution of proteins both among and within families is likely to lead to malnutrition in children rather than in adults. Bornstein and Morgan (4) have shown how religious influences can militate against an adequate share of protein for women and small children and how a figure for average meat consump-tion can be made up of lavish supplies at certain feast times and paucity for long periods in between.

The people who do not get enough protein usually receive inadequate diets as a whole. Thus, in practice, any programme to improve the food situation of low-income groups would have to concentrate very largely on basic foods already in wide use, such as grains and pulses, and much of their protein deficit would be met by the protein in such basic foods.

Protein deficits appear to be most probable in the parts of Latin America where maize is the main element in the popular diet, in equatorial Africa because of the predominance of starchy foods there, and in the rice-eating countries of southeast Asia. In the wheat-eating countries of the Mediterranean basin and the Near East and in the millet and sorghum-consuming zones of the African Savannah, the calorie-protein balance is better. The cereals which constitute the largest part of the protein supply provide more protein for the same quantity of calories.

Projections to 1980

What changes in the protein supply/demand relationship can be expected from the continuance of present trends over the next decade? The FAO Agricultural commodity projections, 1970-1980 (1971) provides some dimensions for this (see Table 2) (5). They originate with current demand data. Adjustments are then made to reflect expected growth in population and income and estimated income elasticity of demand for different foods. Thus these projections refer to market demand only, not to nutritional requirements. They show that, assuming prices remain constant, per caput food demand in developing countries would grow by 8 percent in terms of value over the 1970s, at an annual rate of a little under 1 percent. The number of calories per person per day implied by the projected demand would rise from 2,193 to 2,307 and the protein demand from 56.4 to 59.5 grammes, in both cases an annual increase of 0.5 percent. The satisfaction of these demands would thus mean a modest but definite rise in the quantity and quality of food intake on a national per caput average basis. However, the rise in per caput demand for animal proteins is likely to be much larger in high-income than in developing countries and the gap between the two groups of countries would widen.

There are areas - for example, in west and northwest Africa and in Asia - where national average demand for calories is projected to remain distinctly below the level of requirements. The projections show that in 1980, 42 developing countries with a total population of 1,400 million would, even if market demand is fully met, have average calorie intakes below requirements.

Table 2. Per Caput Daily Food Requirements and Levels of Demand in 1980

	Per caput requirements[1]		Percentage of requirements			
			1970 consumption		1980 demand	
	Calories	Proteins[2]	Calories	Proteins	Calories	Proteins
	Numbers per day	Grammes per day				
World	2 385	38.7	101	173	105	178
High-income countries	2 560	39.5	121	229	123	237
Developed market economies	2 555	39.2	119	228	122	237
U.S.S.R. and Eastern Europe	2 570	40.0	124	232	126	238
Developing countries	2 284	38.4	96	147	101	155
Asia and Far East	2 223	36.6	93	141	99	150
Africa	2 335	41.5	93	141	98	149
Latin America	2 383	37.7	106	172	110	179
Near East	2 456	45.5	97	147	101	153

[1]Revised standards . - [2]Expressed in local proteins.

Because of the projected population increase of about 750 million people in the lower income countries by 1980, the absolute number of underfed people would not fall much over the 1970s. However, the rise in the national average calorie level implies that the average extent of undernourishment of such people would be lessened over the period.

Protein deficiency is hard to judge from these projections because they bear only indirectly on the main consideration which is the distribution of protein foods within particular population groups.

Trade movements of food protein

Per caput availabilities of protein foods in particular countries are affected substantially by trade movements in response to international market incentives. Most of the existing international trade in protein-rich products is directed toward the developed countries, either from other developed countries and "semi-developed" countries like Argentina - where mainly animal products are exported, or from the developing countries - which export specialty products such as frozen shrimps, and oilseeds, oilcake and fishmeal in bulk.

The developing countries are constrained by economic necessities to export such of their production as finds a more remunerative market in the developed countries. Little foreign exchange is available to pay for food movements in the opposite direction. Processed and other speciality food items are imported in small quantities for the limited number of consumers who can afford them. Where food imports are needed on a large scale they are necessarily the cheapest available or what can be obtained on concessional terms.

In certain African countries and Brazil, for example, livestock and meat are exported from some zones while in others large segments of the population remain on very low protein diets because they cannot afford to buy more of the meat which is produced

in the country. Such "perverse" movements are generally founded, however, on solid economics. Recently the Government of Guatemala sensed criticism that beef was being exported from that country to the United States of America while a large part of the domestic population could hardly buy any because the price was too high. In an effort to remedy this, it set a lower price for beef by administrative edict. The result was a sharp drop in production because of lack of incentive to the farmer. More than a hundred thousand tons of rice are exported annually from Nepal, yet in the mountain villages people are said to be starving. To divert exports to them the Government has both to forgo foreign exchange earnings and provide subsidies that will bring down the price to a level they can afford. It has not the means to do this except on a very small scale.

Another subject of nutritionally motivated criticism is the large-scale shipment of potential human protein food supplies such as oilseeds, oilcake, and fishmeal out of the developing countries to meet a steadily growing market demand in Europe, North America and Japan for livestock feed (see Table 3).

In Peru, the fishing of anchoveta for processing into high-protein meal has grown remarkably in recent years. Attracting international investment and management, the industry emerged from obscurity to first place among the world's fishmeal producers in less than a decade. Concurrently, it became the country's principal earner of foreign exchange.

From many developing countries the bulk of such crops as coconuts, peanuts, soybeans and sesameseed has long been exported in the form of whole oilseeds or oilcakes. In those few countries where a significant amount of these crops is processed locally to meet the growing domestic demand for fats and oils, the protein-rich press cake is generally used as fertilizer, animal feed, or fuel, or even wasted altogether. Processing for human nutrition is quite feasible technically; it awaits favourable economic conditions and the necessary initiatives.

Would an increase in the use of oilseed protein concentrates to fortify cereal foods significantly affect world trade in these commodities or the availability of oilcakes for animal feeding? The diversion of oilseeds for use as human food in developing countries can in practice only be gradual. Its effect on world trade patterns or on food supplies in the developed countries could normally be discounted against the additional incentive to growers to expand production. Should the production response in a particular country, however, be inelastic there might be a perceptible effect upon export earnings. In FAO's The state of food and agriculture, 1964 it was shown that an increase of only 1 gramme per person per day in coconut

Table 3. Exports of Potential Protein Food From Developing Countries[1]

	1967	1968	1969
	Million tons		
Products[2]			
Fishmeal	1.82	2.38	2.01
Soybean	0.40	0.33	0.56
Peanut	2.05	2.26	1.78
Cottonseed	1.17	1.15	1.27
Copra	0.85	0.87	0.83
Rapeseed	0.05	0.04	0.05
Sunflowerseed	0.53	0.48	0.39
Sesameseed	0.07	0.07	0.09
Protein equivalent[3]			
Fishmeal	1.09	1.43	1.21
Soybean	0.18	0.15	0.25
Groundnut	0.94	1.04	0.82
Cottonseed	0.48	0.47	0.52
Copra	0.17	0.17	0.17
Rapeseed	0.01	0.01	0.01
Sunflowerseed	0.19	0.17	0.14
Sesameseed	0.03	0.03	0.04
Total	3.09	3.47	3.16

[1] Including minor exports to other developing countries. - [2] Oilseeds and cakes, meal, etc., in terms of cake equivalent. - [3] Protein percentages: fishmeal 60; soybean 44; groundnut 46; cottonseed 41; copra 20; rapeseed 28; sunflowerseed 36; sesame 39.

protein intakes in the Philippines, for example, would be at the expense of a reduction in exports of some 50,000 tons of copra cake. This would mean a loss in export earnings of about U.S. $3 million annually, or about 1.5 percent of the country's annual earnings from coconut products. The proportions of this relationship had not changed substantially in 1971.

Obstacles to increased protein distribution within lower-income countries

An efficient marketing system must adapt the seasonal outflow of produce from the farm to a relatively stable and continuous demand from consumers. This is done by the mobilization of transport and storage facilities, skilled handling and processing, detailed knowledge of supply and demand conditions and sources, the provision of adequate credit, and willingness to accept risks and responsibilities. Limitations of capital, equipment, management and skilled operating staff all bear heavily on the ability of protein food distribution systems in the developing countries to serve lower-income consumers. Animal protein foods require fairly elaborate production and marketing systems if they are to be provided in large quantities and to maintain their quality through to the consumer. Transport is often a limiting factor in the distribution of food products and a major element in its cost. For example, a wholesale price of beef in Accra or Kinshasa of 32 U.S. cents per pound corresponds to 14 cents in Fort Lamy, Chad, since it must be brought over more than 600 miles from the savannah regions either as live animals driven on foot or as carcass by air. Many of the agricultural products containing the most valuable protein are highly perishable, and their marketing calls for special handling, treatment and storage arrangements, especially in tropical climates. The Masai cattle raisers in east Africa, for example, consume large quantities of milk per caput in relation to their income; but their production capacity is limited and the cost of marketing their small surpluses to distant consumers is high.

In developing countries fish are in fairly ample supply in places close to sea coasts, rivers and lakes, but integrated large-scale organization of fishing and marketing is rare. Thus in western Africa fresh fish are plentiful up to a distance of about ten miles from the coast. Only in a few countries, such as Ghana, Ivory Coast and Liberia, has there been a full-scale attempt in recent years to develop a deep-sea fishing fleet, and the cold storage and distribution chain that would enable fish to become a major contributor of protein to the national diet. Dried fish are traded widely in Africa because of relative ease of handling, but losses due to insects and quality deterioration are considerable. These add substantially to the cost of the protein actually reaching the consumer and restrict distribution among lower-income groups accordingly.

The long-standing absence of a marketing system for fish, either fresh or dried, lies behind what might seem a striking nutritional anomaly - the massive exports of fishmeal from Peru while large parts of its 13 million population remain on a low protein diet. Because there has been no system of bringing acceptable fish to the inland population, especially in the sierra, there is little familiarity with fish as a normal ingredient of the diet - except for salted sardines in limited quantity. Eating habits change little when people from the sierra move to Lima and come within easy access of fresh fish at relatively low prices. A comparable situation prevails in developing countries, such as Egypt, India, Mexico and Pakistan, near areas where profitable industries exporting frozen shrimps and prawns have grown up in recent years, and in Mexico in the case of sardines. Inadequate internal marketing arrangements interrelated with lack of consumer interest have effectively limited domestic use. In some cases religious or other taboos play a role, particularly regarding flat fish and crustacea.

It is of course sound economics, from both the enterprise and national point of view, to direct salable produce to the markets where it will bring the greatest return. Development of a strong preference for certain species among consumers with the financial means to make it effective has opened the way to such returns. To be hoped, however, is that the opening of

profitable export markets for certain products and qualities would provide the initial economic basis for associated distribution to less affluent local markets of items of lower value and quality forthcoming as a joint product of the primary enterprise.

Proteins of vegetable origin often require quite elaborate processing, as, for instance, the fermentation and related treatment of soybeans in east Asia and the washing of protein from wheat in India. Centralized industrial processing faces the cost of packaging and distributing such oilseed protein products in consumer-sized lots. In practice this may figure more largely in the final price than either raw material or processing costs. There are special problems in assuring that the product reaches the consumer in unimpaired condition and is presented in a package of convenient size and adequate sales appeal. Unfamiliarity with such processed products and the difficulty of fitting them into established eating habits and preferences, particularly of the lower-income groups, mean that intense promotional efforts will usually be needed, with only limited prospects of a market large enough to repay development costs.

A decade ago many projects to market new protein-rich food based on nutritional formulae were launched without adequate pretesting on a commercial basis and without much understanding of marketing and promotion. Now pretesting and promotion are here, but still most of the new products do not catch on. The incomes of the families which these products are intended to help leave little room for response to the promotional stimuli which build up a quick demand in more affluent consumer societies.

Measures to improve protein food distribution

There are measures which governments can take to improve protein nutrition. Such measures may be designed to raise overall purchasing power in lower-income groups or they may be specific to the distribution of nutritionally desirable food products. How far they are practicable, and the extent to which they are likely to achieve the objective of correcting maldistribution depend on the political complexion of the countries concerned and the funds available to their governments.

Preliminary analyses of a number of Latin American countries show that a moderate change in income distribution there would result in a direct rise of some 9 to 9.5 percent in total food demand over 1970-80 (6). A "drastic" change in income distribution would bring about a 13 to 14 percent increase in demand. Intake of protein food by lower-income groups would undoubtedly benefit. A "drastic" change in income distribution has been carried through in Cuba, for example. Here, distribution of a new protein-rich food would have greatly increased chances of success because the redistribution of income and rationing of many other foods leave ample purchasing power available and limited choice of alternatives.

Another approach for governments is to make it compulsory, for example, that a protein product be included in certain basic processed foods and in institutional diets, wherever such measures can be enforced. The Government of Israel requires that all flour for bread include 2.5 percent soyflour. Similarly, lysine fortification of cereal products might be undertaken by government action. However, while the governments of developing countries may have the desire and authority to introduce such programmes, they may well not possess the means to subsidize the cost. Individual consumers are unlikely to buy protein-fortified products selectively if they are going to cost more.

Mass protein fortification in the developing countries would, of course, be greatly facilitated if there were a supplement which could be added to established basic foods without involving any significant price increase. This implies an ingredient cost of around 10 cents per kilogramme in the case of wheat flour, and perhaps 15 cents for rice. On these terms, even the poorest government could introduce compulsory supplementation. Regrettably, some of our recent hopes for low-cost protein seem still very distant. This seems to be the case with fish protein concentrate (FPC) which, with present technology, still costs too much. According

to a 1971 Tropical Products Institute survey, to compete on the world market FPC would have to be produced at an opportunity cost of only 33 cents per kilogramme. As the lowest estimate for FPC production at the time was 55 cents per kilogramme it seemed unlikely that it could be competitive with other protein concentrates. Comparative prices for other protein sources were soya flour (50 percent protein), 22 cents per kilogramme; and skim milk powder (36 percent protein), 26 cents per kilogramme (7). It also appears that petroleum-based protein suitable for human consumption will be more expensive than was first expected (8). Breeding cereal varieties with a higher protein content is another possibility which has aroused considerable expectations. Issues of production cost and consumer appeal have still to be settled (9).

Marketing requirements

What are the requirements that must be met to give the best chances of success for a new protein food launched on a free market? These are now well known. A detailed treatment was prepared for the United Nations Protein Advisory Group by B. Wickstrom (10). Such a food should have a competitive advantage in price, in some attribute such as quality, convenience, flavour or functional properties that is specifically recognized by the processor or consumer, and there must be effective presentation, distribution and promotion.

If the protein-fortified product must inevitably cost more than the basic foods already available, then it should be offered for sale in the most attractive and palatable forms possible within existing economic limitations. It cannot be too strongly emphasized that protein by itself or protein concentrates are not consciously attractive products to the majority of consumers. Much more attention is needed on the flavour and texture of new protein products.

The obstacles to be overcome in attaining wide commercial use of protein-enriched cereal foods lie not only in their preparation in a safe, nutritious, palatable and sufficiently inexpensive form, but in effective distribution and promotion. In the developing countries the introduction of cheap packaged food must surmount inefficient distribution systems and high mark-ups, low, scattered consumer purchasing power and great attachment to traditional foods. The slow purchasing response to some oilseed protein products put onto the market in India, Nigeria and elsewhere, and the long gestation and high promotion outlay relative to retail sales of Pronutro in South Africa evidence the costs and risks to be faced. Because of the difficulty in obtaining commercial acceptance of new foods, something which can be incorporated into standard items of existing diets may offer the best immediate prospect of distribution in volume. The vehicle would be institutional meals, and bread flours, chapatty and porridge mixes, and so on, launched with publicity for its much higher food value and low cost. The initial success of "filled milk" (imported nonfat dry milk and domestic coconut oil) sales in the Philippines, which climbed from 1 to 43 million litres in four years, is attributed to its similarity to an established product and lower cost.

The trend toward greater consumption of processed foods and prepared meals, even in the developing countries, constitutes an opening for products such as soybeans and cottonseed which have adverse market connotations - because of wartime and livestock feed associations, and negative or at best passive colour, flavour and consistency attributes. This also facilitates greater emphasis on brand names, and separation of high- and low-income markets permitting a commercial enterprise to sell at lower prices to the poorer market than would otherwise be possible.

Setting up a plant in a developing country where most of the ingredients are available locally solves the foreign exchange problem and would seem to offer the best prospects of sales to the population groups most needing additional protein. While there have been many such ventures it is difficult to point to many that have taken root and flourished. Incaparina goes on in Central America and Colombia. In India the Tata Company is reported to be expanding its production from groundnuts of protein isolate for food uses from 2 to 6 tons per day. The

Gujarat Agro-Industries Corporation is sponsoring a plant to process cottonseed for protein food use. Modern Bakeries is about to open new branches in several Indian cities. Its managers claim that a part of their amino acid-fortified product is bought by protein-deficient groups.

There are government-sponsored projects to launch oilseed-based protein foods for vulnerable groups in a number of north African and Near Eastern countries. Superamine - using oilseed and chick-pea protein sources - went well initially in Algeria, but consumer demand has probably been overestimated. It has been commented that the substantial promotional investment, in the long run, helped competing products aimed at a higher-income market.

The weaning food FAFFA (wheat flour 57 percent, defatted soyflour 18, pea flour 10, sugar 8, defatted skim milk 5, salt 1, and additives 1) has been marketed now for several years in southwestern Ethiopia. Sales reached 700 tons over the two years 1970-71. In one area investigated, 16 percent of all the children in the correct age group were FAFFA consumers, using about 20 kilogrammes per year of FAFFA or 4 kilogrammes of proteins. Whether this means a net supplementation of the diet with the quantity stated was not determined. According to O. Gedda (11) (1971) these results are a basis for cautious optimism (12).

Conclusions

1. Economic forces tend to attract the production of protein food materials and direct them into the most profitable uses. Important determinants are production and processing techniques and costs, consumer attitudes and spending power and initiatives in marketing. Present world-use patterns for protein reflect these factors in the main. They result in such nutritional anomalies as fish protein exports from Peru and oilseed protein from India while many people in those countries have diets that are protein deficient.

2. Measures are being taken in many countries to improve distribution of protein foods to vulnerable groups. Redistribution of income would permit such groups to purchase more protein food at free market prices, provided this group was not too large in relation to the total income for redistribution.

More specific measures to make increased protein food supplies available to groups with deficient diets are feasible, but involve major international financial and organizational assistance. Approaches include direct provision of protein foods free or at subsidized prices to children in schools, and to mothers and preschool children through designated shops or mobile units, sale of protein-fortified foods or cereals combined with educational and sales promotion campaigns to shift consumption expenditure toward them, and similar measures to modify free market purchases.

3. There is still a long way to go before the needs of the population groups presently suffering from a maldistribution of protein food are met. The scale of the problem calls for major inputs of capital, organizing ability, and technical and promotional training.

4. The need for specific marketing arrangements on both international and national levels to compensate for income inequalities and consumption preferences that are nutritionally perverse is likely to increase rather than diminish.

References

1. FAO, Agricultural commodity projections, 1970-1980, Vols. I and II, Rome, 1971.

2. Distribution of income in the Indian economy. 1953-54 to 1956-57. Reserve Bank of India Bulletin, September 1962.

3. The paragraphs summarizing the significance of various commodities in the world protein food intake are based on Chapter III, "Protein nutrition: needs and prospects," of FAO, State of food and agriculture, 1964, Rome 1964.

4. Bornstein, A. and Morgan, T.B. Socio-cultural factors in relation to food and nutrition with reference to the Near East Region. Paper presented at the FAO/SIDA (Swedish Inter-

national Development Agency) Inter-Regional Seminar on Food Promotion, Turkey, October 1971.

5. FAO, Agricultural commodity projections, 1970-1980, Vols. I and II, Rome, 1971.

6. FAO, The impact on demand of changes in income distribution, CCP 72/WP.2, Rome, 1971.

7. Halliday, D. and Disney, J. G. Fish protein concentrate: a review. London, Tropical Products Institute, 1971.

8. Around 50 cents per kilogramme of pure protein from a plant of 10,000 tons per year capacity. Food Technology in Australia, 23 (7), July 1971. An informal comment at the Reading Conference was that the break-even point for investment in a petroleum protein plant was a soybean price of $130 per ton. Below this level protein production from petroleum would not be competitive.

9. Penstrup-Andersen, P. The feasibility of introducing opaque-2 maize for human consumption in Colombia. Cali, Centro Internacional de Agricultura Tropical, 1971.

10. Wickstrom, B. Marketing of protein-rich foods in developing countries. FAO/WHO/UNICEF Protein Advisory Group, New York, United Nations, 1971.

11. Gedda, O. Marketing of the weaning food "FAFFA." Paper presented at the FAO/UNICEF Eastern Africa Regional Seminar on the Production, Utilization and Marketing of Soybeans, Kampala, February 1971.

12. The only new protein food line mentioned at the Reading Symposium was PVM developed by the National Food Research Institute in Pretoria and marketed by a Johannesburg firm. Based on soya flour, fish protein concentrate, egg powder and milk powder, it contained 46 percent protein and could be sold with various flavours including banana. It was convenient to add as a gravy or flavouring to maize mixtures. The cost was $1.06 per kilogramme but only 28 grammes were required per day to meet the nutritional requirements of a child.

Guadalajara, Mexico

CONFERENCE ON NUTRITION EDUCATION

On 31 August and 1 September 1972 an international multidisciplinary Conference on Nutrition Education was convened in Guadalajara, Mexico, to take a global overview and to exchange views and experiences from some new pilot efforts. The Conference was sponsored by the Committee on Nutrition Education of the Public, International Union of Nutritional Sciences, and the Universidad Autonoma de Guadalajara; Dr. Luis Garibay G., Rector, and his staff participated actively in the entire conference. The thirty-two participants from fourteen countries included specialists in the fields of communications, anthropology, sociology, psychology, economics, public health, agricultural extension, food technology and nutrition. There was representation from FAO, Unesco, UNICEF, bilateral aid programs, government agencies, universities, private foundations, voluntary organizations and commercial firms engaged in international operations.

In the interdisciplinary group that assembled there were distinct differences of opinion on a number of subjects, such as the potential for mass media, the effects of commercial advertising and appropriate roles for government and industry. However, there was clear agreement on the need for contributions from many quarters and there was a genuine effort to gain new insights into

what the most fruitful lines of action might be for countries in various stages of development.

Food habits and nutrition education

Food beliefs, attitudes and habits came up at various points throughout the Conference, but special attention was given to this area at the beginning of the working sessions. An intensive three months' study, conducted in Pakistan, of traditional beliefs about food showed that these beliefs are strongly held and are mostly derived from the Graeco-Arabic medical system known as Unani (a system which was revived in Europe with the Renaissance and continued to dominate medical thought in Europe and North America until about 100 years ago). The food practices of a high percentage of professional families, as well as most of the general public, were found to be based on this system. A manual for the guidance of health workers with the title "Modernizing traditional beliefs about food in West Pakistan" is under preparation. Nutrition problems and adaptation of migrants in a new cultural setting was a topic for discussion. The special problems of migrants were seen in various situations: rural-urban migration; migrants who never settle in one location for an extended period; movement to a new country with a different language; etc. Special efforts are almost always required to reach these groups in order to alleviate their nutrition problems.

The International Committee for the Anthropology of Food and Food Habits serves as a focal point of service to those wishing to apply studies of food habits to nutrition programming. The Committee is encouraging anthropologists to include foods and nutrition in their research and is facilitating communication among them. A questionnaire guideline for field investigations is available. A documentation center has been established at the Museum d'Histoire Naturelle, Paris, and the Committee hopes to establish a journal, FOODWAYS, for publication of research papers, bibliographies, abstracts, glossaries, and other communications in this field.

Communications

The limitations of mass media, particularly in less developed countries, as well as their utility for effecting change in dietary practices were pointed out. The mass media can be supportive of other educational efforts. The power of the person-to-person approach should not be minimized and use should be made of the many traditional channels of communications in the less developed countries. Specialists in communications and nutrition should work jointly from the very initiation of planning of nutrition education activities.

An extensive pilot experiment in India trying out various communications channels according to modern advertising concepts and techniques was described. Czechoslovakia has had an annual nutrition education campaign, including intensive use of mass media, for many years. It was reported that systematic surveys of knowledge had provided evidence on the degree of effectiveness of certain approaches and had enabled adjustments of the campaigns accordingly. Reliable data on practices are much more difficult to obtain and the need to attempt to do this should be judged in each particular situation.

The role of the private sector

The positive contributions that are being made and can be made by commercial firms through appropriate promotion and advertising, consumer services, support of nutrition education and training, etc., as well as the possible negative effects of certain kinds of food advertising, were discussed. The less developed countries will be increasingly affected by the actions of industry. There was a fairly wide spectrum of opinions on the respective roles of the food industry and government agencies, but there was a consensus that those interested in promoting good nutrition should cooperate with food companies seriously interested in increasing their positive contributions in this area. Some of the food industry representatives felt that the industry would be willing to do much more in nutrition education if it were reasonably clear what steps should be taken and what

the priorities are.

Foundations supported by the food industry, such as the Nutrition Foundations in Sweden, the United Kingdom and the United States, are becoming increasingly active and effective in promoting basic and applied research and training in nutrition education, in supporting specific programs in nutrition training and education, and in facilitating cooperation between the food industry and government agencies to improve nutrition in various ways. Institutional feeding programs could be tied in with nutrition education activities and this combined approach should begin in the preschool years.

Community participation

In the less developed countries organization of communities for various activities, including nutrition education, will for some years to come be a key factor in improvement of nutrition. An innovative pilot project in the Philippines which involved organization and training of "unit leaders", each one covering ten households, was described. The unit leaders also promoted and organized various activities for the improvement of nutrition and health, including nutrition education.

In Brazil an agricultural credit and extension program, ABCAR, has had considerable success in organizing communities, largely through the training and support of local volunteer leaders and motivation and support of the people of the community and local public and private agencies. It was reported that 2,640 technicians are working full-time in the field, with the support of 750 technicians at regional and state levels. The extension agents involved include agronomists, veterinarians, home economists, social workers, teachers, nutritionists and other professionals. Training programs are carried out in close cooperation with universities.

Evaluation

Evaluation should be a constructive element of any project and in general most of the evaluation should be done by those operating the project. Independent evaluation, however, can also be useful. Recent evaluations of "nutrition rehabilitation centers" in Haiti and Guatemala have shown that while improvements in health of children could be noted while they were attending the centers, longer-term effects were not as good as might have been hoped for, in part due to a tendency to emphasize treatment of the malnourished children rather than education of the mothers. Such evaluations sharpen up the needs for adjustments in programs. Another evaluation of nutrition rehabilitation center activity carried out in Uganda revealed that recording of effects on health (height, weight, morbidity, mortality) alone was of limited use in determining what specific changes should be made to improve programs. A project activity should be seen as possibly making changes in various parts of a complex of factors that can affect nutrition. If possible, the motivation and behavior of those served by the project should be studied. This is a difficult area and only beginnings have been made with respect to evaluation of nutrition education.

In Mexico, several approaches have been tried to modify infant feeding practices in villages with low incomes. Where the survival and health of infants and young children were followed for several years, it was found that a relatively simple educational program, involving supervised aides with a moderate level of training, could essentially eliminate the more severe malnutrition which frequently leads to mortality. Education of mothers to bring about relatively modest changes in the diet using foods available to them and with attention to sanitation and personal hygiene was shown to have a profound beneficial effect.

Training of personnel for nutrition education

Discussing the situation in the more developed countries, it was noted that there is a great need for establishing minimum standards for those accepted as nutrition specialists and for improving the training of professionals and paraprofessionals in various fields so that their positive influence can help protect against permeation of misinformation which often leads to practices that are uneconomic as well as

counterproductive to good nutrition and health.

The special problems of malnutrition and the need for more trained personnel in African countries were described. An innovative program in Cameroon attempts to meet the needs through providing medical and health worker teams with extensive training in field work and maximum adaptation of the training to the most pressing needs of the country, particularly in the rural areas. On completion of training the teams continue to work as units, with the paramedical workers carrying as much of the load as possible.

FAO, in cooperation with WHO and UNICEF, and as part of its broad program of assistance towards improvement of nutrition, has for many years been helping developing countries train personnel for nutrition education work. FAO's increasing cooperation with communications service units in the United Nations system was described. Unesco activities related to nutrition education, with special reference to teacher training and the integration of nutrition education into formal schooling at all levels, were presented.

Further information on the Conference and copies of background papers may be obtained from Dr. L. J. Teply, UNICEF, United Nations, New York. Dr. Teply is Chairman of the IUNS Committee on Nutrition Education of the Public.

Neuherberg, Germany

SEED PROTEIN IMPROVEMENT

The first full-scale coordination meeting with the expanded joint FAO/IAEA/GSF program on the use of nuclear techniques to improve seed protein was held at the headquarters of the host Institute, the Gesellschaft für Strahlen- und Umweltforschung (GSF), at Neuherberg, near Munich, Germany, 26-30 June 1972. It was attended by sixteen research contract holders from developing countries in Asia, Latin America and Africa, plus fifteen scientists from developed countries. Dr. R. A. Luse of IAEA served as Scientific Secretary.

The Danish Atomic Energy Commission, Riso, reported screening 6000 lines of mutagen-treated barley and detecting six high-lysine mutants. The lysine content is from 15-45% higher than that of the mother varieties, with a maximum yield depression of 25%.

The Atomic Energy Centre, Dacca, Bangladesh, reported five rice mutants with a protein content higher than in the parents and with comparable yield. These mutants were initially screened on the basis of earliness.

Researchers in Taiwan found that in japonica rice, irradiation of seeds results in a reduction of average protein content in the M_2 generation. Standard deviation is increased as compared to the control. Up to a limit, the higher the dose, the higher the deviation.

The Radiation Research Institute, Seoul, Korea, reported that mutant rice lines (M_3 - M_7) had a range of protein content of from 70% to 170% that of the mother line. The protein content of the high-protein mutants increased with N-fertilization much more than in the mother line. Most importantly, the grain yields of high-protein mutants were not statistically lower than those of the mother variety.

The Institute of Radiation Breeding, Ohmiya, Japan, reported the protein content of 718 rice mutants derived from both a nonglutinous and a glutinous variety, 754 native varieties collected from many remote areas throughout Japan and 265 commercial varieties grown in 817 locations. The variation of protein content was the largest in mutants (4-16%), relatively large in native varieties (5-12%) and smallest

in commercial varieties (5.5-10%). This suggested the potential of breeding high-protein rice varieties. Since Japanese rice varieties have been bred without the aim of protein improvement, it was thought that mutants can play an important role in achieving this objective. As several high-protein M_3 lines which segregated for no morphological mutations have been obtained, it is expected that it will be possible to breed high-protein rice varieties with the superior agronomic traits of the original variety.

In general, it may be said that cereal breeders using induced mutations and careful selection and screening techniques have found high-protein mutants with a frequency of roughly one in a thousand lines. Since protein contents have been found which are higher than in native, even "exotic", varieties, it is felt that the use of induced mutations has proved of great value in providing breeding materials for raising the protein content of cereals.

Six papers were presented by research cooperators working with legumes. Since mutation breeding is generally just starting with these important sources of protein, the reports were mostly of a preliminary nature, except for that from the University of Bonn, which reported two fasciated mutants in peas with from 20-70% increase in protein content measured over three subsequent generations.

Meeting participants emphasized the need for faster screening methods, both for seed protein content and protein quality. Four papers were read on new techniques that should permit more rapid analysis. Faster methods for nutritional evaluation were also discussed.

RAL

Sao Paulo, Brazil

WORKSHOP ON MARKETING OF NEW PROTEIN FOODS

This Workshop, sponsored by the Brazilian Food Manufacturers Association, was held in Sao Paulo from 23 to 26 October, 1972. It was attended by representatives of the Brazilian food industry, who gave primary attention to three areas of food marketing:

a) donated foods
b) low-cost protein foods
c) high-cost protein foods

Recommendations drafted by the participants in these three areas are as follows:

Donated foods

1. The Government should state the need for donated foods, establish priorities and prepare medium- and long-range plans for purchase and payment, also enabling industry to plan the necessary investments and their financing.

2. The projected National Institute of Food and Nutrition should incorporate permanent representatives of the Association into its future structure in order to accomplish its main objective; that is, improving the nutritional condition of the population, by using in conjunction with private industry the most successful resources for consumer study, product development and marketing techniques.

Low-cost protein foods

1. Government and industry should cooperate in procuring basic and adequate data on habits and attitudes of the Brazilian population.

2. Government should encourage the production of these foods through adequate tax exemption and financing programs for fortified staple foods and specially-designed, low-cost protein foods.

3. Industry in all its advertising and promotion should present factual, adequate information

on the nutritional properties of the products.

High-cost protein foods

1. Industry should increase the production of these foods, using modern tools of production to attempt to reduce the final price to the consumer.

Dr. Bo Wickstrom, Professor of Marketing, University of Gothenburg, Sweden, attended the conference and provided guidance to the discussion. USAID was also a sponsor and made available the services of Mr. Paul R. Crowley, Economic Research Service, U.S. Department of Agriculture, Washington, D.C.

Ankara, Turkey

THE INTERNATIONAL WINTER WHEAT CONFERENCE

The Conference, held on 5-9 June 1972, was organized by the wheat research team of the Nebraska Agricultural Experiment Station - Agricultural Research Service. The cooperative program to evaluate improved winter wheat varieties from different countries led to the emergence of a few winter varieties with superior performance characteristics. Lysine expressed as per cent of protein was negatively correlated with protein. Varietal differences in maturity, plant height, lodging, disease resistance and other agronomic characteristics were observed. There was excellent phenotype expression of genes for high protein in some varieties. Three cultivars with genes for high grain protein content showed this trait consistently in different international environments. The Conference was held to assess the significance of these findings and develop procedures to accelerate the agronomic and nutritional improvement of winter wheat. Ninety-seven participants from twenty-seven countries attended. The Proceedings contains the written texts of most of the papers presented at the meeting.

Research Bulletin No. 248, September 1972, on results of the second international winter wheat performance nursery and Research Bulletin No. 251, October 1972, on winter wheat cultivar performance in an international survey of environments have also been issued as companion volumes.

For further details and copies of the publications, please contact Dr. V. A. Johnson, Agricultural Research Service, USDA, University of Nebraska, Lincoln, Nebraska, U.S.A.

El Batan, Mexico

CIMMYT - PURDUE INTERNATIONAL SYMPOSIUM ON PROTEIN QUALITY IN MAIZE

The worldwide status of development of maize with improved protein nutritive quality was reviewed comprehensively in an International Symposium on Protein Quality in Maize held from 4-8 December 1972 at the International Center for Improvement of Maize and Wheat (CIMMYT). The meeting, sponsored by CIMMYT and Purdue University (Lafayette, Indiana, U.S.A.) was attended by agricultural specialists and food scientists representing many countries and international agencies. It was at Purdue University that the development

of opaque-2 maize, known also as high-lysine maize, was first reported in 1964.

In welcoming the participants the Director of CIMMYT, Dr. Haldore Hanson, pointed out that this center is one of a new network of international regional agricultural research institutes in six countries supported by international, bilateral and foundation funds. These include the International Rice Research Institute in the Philippines (IRRI), a potato center in Peru (CIP), two crops research centers for the humid tropics, one in Colombia (CIAT) and the other in Nigeria (IITA), a tropical dryland crop institute in India (ICRISAT) and a new vegetable group in Taiwan (AVRC).

An analysis was presented of world protein needs in relation to increasing population in the developing regions and the trend toward increased meat consumption in the industrial countries, which, in the case of the U.S., requires a per capita daily utilization of 11,000 plant food calories. It was doubted that current trends in crop production could support the identifiable need by the populations of the developing countries by 1983 for 2-1/2 times their present supply of protein, the Green Revolution notwithstanding. There would seem to be no solution to the problem while the industrial countries continue to emphasize increased meat production and consumption unless new technologies (such as amino acid fortification of staple foods) and special food distribution methods are quickly introduced to supplement agricultural production.

Reports on human feeding studies with maize of improved nutritional quality emphasized the supplementary value of suitably-prepared opaque-2 corn for breast-fed infants between four and six months. New strains of flint corn with the high-lysine trait which show nutritional qualities equal to milk for children are now available. The best nitrogen retention in children was achieved, however, by supplementing ordinary maize with lysine, tryptophan and leucine. Lysine and tryptophan also improved corn/bean food mixtures. Protein supplements such as soy and cottonseed flours, fish protein concentrate and yeast were similarly effective in raising corn protein to the nutritional level of animal protein. A report from CIAT indicated that opaque-2 corn used in swine feeding produced growth at least as good as that with soy flour supplements fed with normal corn. On the other hand, the higher lysine and tryptophan levels of the floury-2 mutant produce little nutritional improvement over normal corn. In some opaque-2 mutants the protein improvement comes about primarily through increased germ size rather than from any substantive improvement in endosperm proteins. In fact, it is now clear that in mutant maizes, suppression of zein synthesis is accompanied by an increase in germ size. This emphasizes the need to analyze the endosperm protein of mutants for increased essential amino acids when genetic selections are made.

At the present time only 0.2% of the U.S. crop is of the opaque-2 type. It has 10 to 15% lower yield then standard corn, due primarily to lower kernel density associated with loose packing of starch; this softness also makes the kernel more susceptible to insects. Generally, opaque-2 maize contains 2% more moisture at harvest, thus requiring drying more frequently. Traditional opaque-2 corn has several deficiences in processing quality, due primarily to its softness. The yield of usable grits on milling is low and flour by-product (i.e. fines) is high. It is not acceptable for tortillas or arepas, which require a more flinty material. Milled, degermed opaque-2 corn meal or grits show little improvement in nutritional quality over non-opaque-2 products; accordingly,use of the whole grain for food in which the germ is retained is recommended. In spite of these factors there appears to be adequate genetic variability in these mutants to achieve further improvement in their characteristics together with improvement in nutritional quality.

Modifier genes can be introduced to change the soft texture to a flinty type; in other words, to achieve increased starch packing. Such types are much less susceptible to insect attack and the yield of edible hard corn grits in milling is higher. The slow drying problem can be improved by selection. There seems to be no

question that varieties with desirable agronomic and food-use traits in addition to improved protein quality can be achieved.

An unresolved discrepancy at this time is the finding by U.S. breeders that floury-2 mutants with increased lysine and tryptophan values do not support growth in animals comparable to that provided by opaque-2, whereas in the hands of Danish workers, these floury-2 mutants showed good nutrient availability and quality.

A leading U.S. commercial breeder believes that new high-lysine maize varieties currently under development will compete successfully in yield, vitreousness and in other desirable qualities with standard dent corn varieties. This is being accomplished by selection and backcrossing. The technique of double mutant combinations is also useful in producing material of good yield with dense endosperm. Due to the economics of corn utilization in the U.S. and the ready availability there of protein feeding supplements, he foresaw only slow introduction and production of even the new improved varieties in the U.S. On the other hand, he believes that the production and use of high-lysine maize will increase most rapidly in countries where corn is important for both food and animal feed.

Market trading and handling of opaque-2 corn will be difficult unless a rapid and simple method can be applied which permits its ready identification. Until such a test is available, its primary utilization will be for swine and poultry raising on the same farm on which it is produced. As for adequate production and sale for human food use, subsidies or premiums may be necessary to induce farmers to grow it.

A very encouraging report on the introduction and acceptance of high-lysine maize in Brazil, particularly by farmers producing swine, was presented. Since few small farmers in Brazil have access to protein supplements when feeding ordinary corn to pigs, the opaque-2 material is being readily and rapidly accepted on the basis of clear evidence that it produces improved gains by these meat animals. It also appears to be well accepted for food use in that country.

The CIMMYT group believes that for high-lysine corn to become effective in providing the food needed in the next ten years, governments must push more strongly for increased organization, research and extension in crop production. They recommended that opaque-2 corn be developed and distributed as standard varieties and not as hybrids, since developing countries do not have the resources to support the cost and complexity of a hybrid seed industry.

The final day of the conference was devoted to workshops and practical demonstrations of breeding methodology, chemical and biological screening techniques, methods for introducing improved varieties at the farm level and analysis of economic and social factors in acceptance of improved varieties.

Proceedings of the symposium will be published.

Bogota, Colombia

PRODUCTION AND MARKETING OF COMPOSITE FLOUR BAKERY PRODUCTS AND PASTA GOODS

This meeting was sponsored by the International Cereal Chemists (ICC) Study Group on Composite Flours, in cooperation with the Agricultural Services Division, FAO, the Center for Application of Science and Technology to the Development of Latin America (CECTAL) and the Institute for Technological Research (IIT), Bogota, Colombia. It was held at IIT on 23-27 October 1972.

Representatives from numerous governments and technical organizations attended this meeting to review recent developments in utilizing flours from tropical root crops such as cassava, or from various cereals other than wheat, in combination with oilseed protein concentrates such as soybean flour and wheat flour itself, in the production of bread, biscuits and pasta foods. It was appropriate to hold this meeting in Bogota because it is the site of a bilateral aid project between the Governments of Colombia and the Netherlands, with the assistance of FAO, which has been in progress for three years and whose purpose it is to produce such products at a commercial level in Bogota (at IIT) and to evaluate their consumer acceptance and marketing potential there.

A variety of informative papers and discussions were presented dealing with market research, agricultural, economic and supply factors, the history of the FAO composite flour program, the technology for manufacture of various composite flour products, and the interest of governments and international agencies in carrying forward these developments. Considerable new information was made available regarding the use of food-grade emulsifying products for bread production which permits incorporation of significant quantities of protein concentrates either into wheat flour containing the protein supplements, or in composite flours (from nonwheat sources) supplemented with the same protein concentrates. Publication of a symposium proceedings is planned; it may be obtained by writing to IIT or to Ir. D. deRuiter, Institute for Cereals, Flour and Bread, TNO, Wageningen, The Netherlands.

NEW UNIVERSITY PROGRAMS ON INTERNATIONAL NUTRITION AND DEVELOPMENT PLANNING AND POLICY

Cornell University and the Massachusetts Institute of Technology are separately initiating interdisciplinary programs of training and research in problems relating to nutrition, national development and planning. In both centers the activities when fully developed will include training and research programs for individuals from low-income countries and for others interested in working in the broad field of nutrition and development planning and policy and program implementation. Both the institutions already have close ties with operational programs in several developing countries.

The MIT program, which is being supported by a Rockefeller Foundation grant, will be affiliated with both the Department of Nutrition and Food Science and the Center for International Studies and will have the cooperation of the Harvard Development Advisory Service and the Harvard Center for Population Studies. Dr. F. James Levinson will be in charge. In addition to training and research, the MIT program also intends to offer advisory services to governments and international agencies in the area of nutrition planning and programming.

The program at Cornell includes a variety of training courses under three broad categories and will provide opportunities for field work tailored to the needs of each individual participant. It will be a cooperative undertaking of several different departments of Cornell University and their faculties. Drs. M. C. Latham and D. L. Call are program co-directors.

Further information regarding these programs at MIT and Cornell university may be obtained from:

Dr. F. James Levinson
Dept. of Nutrition and Food Science
MIT, Cambridge, Mass. 02135

and

Dr. Michael C. Latham
Professor of International Nutrition
Graduate School of Nutrition
Cornell University, Ithaca, N. Y. 14850

LACTOSE TOLERANCE TESTS*

At a recent symposium of the Swedish Nutrition Foundation on "Intestinal enzyme deficiencies and their nutritional implications", held from 14-16 August 1972 and attended by investigators from Sweden, Denmark, England, France, Finland, Switzerland, U.S.A. and Zambia, the following recommendations were made for the performance of lactose tolerance tests in a laboratory. A simplified procedure was suggested for use in studies on prevalence. It should be pointed out, however, that the test proposed will identify the prevalence of low lactase activity only.

Procedure

1. The patient should ideally be fasted overnight, or alternatively for at least 6 hours.

2. The amount of lactose used for the tolerance test should be as follows:
for adults: 50g
for infants and children: 2g/kg body weight (max 50g).

(Note: A calculation of lactose dose per unit body surface area (e.g. 50g/sqm) does not seem to give any advantage which makes up for the extra work involved. It may be of value when comparing the situation in different age groups.)

3. Lactose should be given as a 10% solution/suspension in water and preferably at room temperature.

4. Capillary (not venous) blood should be obtained and analyzed for glucose. Determination with glucose oxidase is recommended, but it is recognized that the use of automatic equipment often makes a ferricyanide method necessary.

5. Blood samples should be taken as follows:
before lactose administration: 2 samples with 5 or 10 minutes interval (mean value to be used).
after lactose administration: at 15, 30, 45 and 60 minutes. A sample at 90 minutes may sometimes give additional information but is not regarded as obligatory.

6. A blood glucose rise by 25mg/100 ml or more indicates efficient hydrolysis and absorption of lactose. A rise below 20 mg/100 ml suggests low lactase activity. A value between 20 and 25 mg/100 ml should be regarded as borderline. If diarrhea occurs (see below), the patient probably has low lactase activity.

7. Ideally, a "flat" lactose tolerance test result (i. e. minimal increase in blood glucose) should be followed by a glucose plus galactose test, in order to exclude impaired monosaccharide absorption or increased

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*The PAG working group on nutritional implications of milk intolerance (PAG Bulletin Vol. II, No. 2, 1972) recommended further studies to obtain "data on the prevalence of low lactase activity in non-Caucasian population groups using standardized procedures". The working group felt the need to develop a protocol on methodology for use in field studies and aimed at the determination of low lactase activity and of milk (lactose) intolerance.

peripheral glucose uptake in the tissues.

8. A flat lactose tolerance test result is strong evidence of low lactase activity. However, it does not necessarily mean that the patient is intolerant to lactose. This can only be evaluated by elucidation of signs and symptoms. The subject should be advised to carefully report his or her experience in this respect, not only during the period of blood sampling but also during the day and night following the test.

9. Prevalence studies may be performed with a simplified procedure. Fasting time, dose and mode of administration of lactose should be the same as described above. Blood samples should be taken at 0 (single sample), 15, 30 and 45 minutes. If for practical reasons only three blood samples can be obtained they should be taken at the following times: 0, 20 and 40 minutes.

In prevalence studies, it is of fundamental importance to register any clinical signs of intolerance which may appear after the lactose load, both during the time of blood sampling and the remainder of the day. A glucose-galactose test is unnecessary in prevalence studies.

UNDP ASSISTANCE FOR A GLOBAL PROJECT*

Research on the utilization of the carob in the production of microbial protein ($82,100)

At its tenth session, the Governing Council of UNDP approved a project for assistance to the Government of Cyprus for the installation of a pilot plant for the production of microbial protein for animal feed utilizing the carob bean. Carob trees are cultivated principally in the Mediterranean area and yield a pod containing beans. The pods, after coarse grinding, are used for animal feed (kibbled carob) and gum is produced from the actual bean. UNDP felt that because the project could be important to other countries which also cultivate carob trees, the project should be treated as a global research activity and its results made available to all interested countries.

On the basis of advice received and in collaboration with FAO, UNDP allocated funds for preproject activities to define in more detail the requirements for a pilot plant and to carry out some necessary feeding trials on animals before deciding to construct a pilot plant. The Protein Advisory Group reviewed the findings of the preliminary research work and recommended the need for additional supplementary technical data before the process could be considered feasible for up-scaling and entering into the pilot-plant stage. Furthermore, the PAG recommended an economic study to obtain more information on the utilization of the whole carob pod. The PAG also considered that the animal feed tests, carried out principally on rats, were inconclusive and that further tests were necessary on chickens, pigs, etc.

Based on these comments and on the advice of FAO, UNDP extended the preproject activities to include production in the laboratory of a limited quantity of fungal protein grown on carob bean substrate to be used in further animal feed trials.

The actual feeding trials will be carried out in an independent agricultural research institute concerned with biochemical evaluations. During this period an economic study will be initiated under the supervision of FAO as Executive Agency on the overall utilization of the carob pod. It is expected that the total time required for completing a full range of tests will not exceed 12 months from the time the trial batch of feedstuffs is delivered to the testing laboratory. The results of this work

*Based on document DP/L.257 (Vol. VII) of 21 November 1972.

will be made available to all interested governments. It is not envisaged that any further assistance will be requested from UNDP after the results and report on these studies are completed.

UNESCO ESTABLISHES SCIENTIFIC INFORMATION RETRIEVAL SYSTEM*

Foundations have been laid by the General Conference of the United Nations Educational, Scientific and Cultural Organization (Unesco) in Paris for a world scientific and technical information system to help scientists and engineers to get easier access to the two-million-odd articles published every year in 70,000 specialized journals. The concept of the system, known as UNISIST, was approved at the Conference's program commission, representing most of the 130 Member States.

The development of UNISIST has been carried out by Unesco and the International Council of Scientific Unions in a joint action, the former representing governments and the latter the world scientific community. The program will be supervised by a steering committee with members from 18 to 23 nations. Its staff would consist of a unit with Unesco's Secretariat in Paris.

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*Press Release UNESCO/2055, 25 October 1972. See Bulletin Vol. II, No. 4, 1972, footnote page 6.

RESEARCH ON LEGUMES AT THE NATIONAL RESEARCH COUNCIL OF CANADA

The Prairie Regional Laboratory of the Council, in Saskatoon, Saskatchewan, in cooperation with the University of Saskatchewan and the Canadian Department of Agriculture, has been carrying out research on the production and utilization of field peas. The studies include breeding and selection of new varieties with higher protein content, the recovery of starch and protein from peas by new technologies, the development from such materials of milk replacers for livestock and the fabrication of an edible meat analog from the purified pea protein. The work also includes nutritional and sensory evaluation of these and various derived food products. Cooperative studies are also under way on fava beans (broad bean) with the University of Manitoba. Further information may be obtained from Dr. Burton M. Craig, Director, Prairie Regional Laboratory, Saskatoon, Saskatchewan, Canada.

FRENCH PETROLEUM PLANT PRODUCING PROTEIN BY FERMENTATION*

In December 1972, BP France's Cap Lavera plant began delivery of biosynthetic protein from petroleum by-products to mixed feed manufacturers under the brand name "Toprina". Although annual production from this pilot plant will not reach its full annual capacity of 20,000 tons for a year, the decision reportedly has already been made to build a larger plant with an annual capacity of 100,000 tons.

The synthetic product is a tasteless, odorless powder which contains about 70 per cent protein, or about 1.6 times the 44 per cent protein content in soybean meal and 8 per cent more protein than fishmeal.

*From Foreign Agriculture, January 22, 1973.

PROTEIN FOOD DEVELOPMENT IN THAILAND (1969-1971)

The Institute of Food Research and Product Development (IFRPD), Kasetsart University, Bangkok, Thailand, reports on development and field evaluation of new protein foods including fortified soy milk, high-protein noodles, weaning foods, textured vegetable protein foods, coconut products and mung bean products. Analyses for chemical and nutritional values of various products are reported as well as recipes for various foods.

Address requests for more details to:
Director, Institute of Food Research and Product Development, Kasetsart University, Bangkok, Thailand.

COTTONSEED PROTEIN AND MICROBIAL PROTEIN

Annual report (in Spanish) dealing with developments at the Instituto Centroamericano de Investigacion y Tecnologia Industrial (ICAITI), Guatemala, C.A., in new technologies for production of protein concentrates from cottonseed, wet protein extraction procedures, formulation of high-protein food products, and protein production by means of single cell microorganisms.

A. K. Smith and S. J. Circle, eds.:

SOYBEANS: CHEMISTRY AND TECHNOLOGY. VOLUME I, PROTEINS

The scope of soybean use in the world and particularly in the U.S. has expanded over the last two decades. This increasing utilization has been more than paralleled by the increase in production. Active efforts are also under way toward increasing soy production and utilization in many other countries. These soy-centered achievements have been made possible by the dedicated research efforts of various teams of scientists and the sustained financial support extended to them by several U.S. institutions The appearance of this book at this juncture will be of great value to the "new" countries, insofar as soybean production and technology is concerned, in understanding the problems of processing and utilization and means for overcoming them.

The book reviews and summarizes two decades of research and development on the several food uses of soybean products. It is authoritative since most of the contributors, and the editors as well, are recognized pioneers in much of the research which has brought soybean science and technology to its present advanced and wide-ranging utilitarian stage.

The current status of the chemistry and technology (including a chapter on marketing) of the soybean and its products are clearly described in twelve chapters. Each chapter ends with an extensive bibliography and the volume also contains an appendix giving a glossary of soybean terms, U.S. marketing standards and an index.

Smith, Allan K., and Sidney J. Circle (eds.). 1972. Soybeans: chemistry and technology. Volume 1, Proteins. The Avi Publishing Co., Westport, Conn., U.S.A. 470 pp. $23.00 in U.S.; $24.00 elsewhere.

RECENT PUBLICATIONS

CFTRI. 1972. Report on study of milk consumption pattern in Bangalore City. Prepared for the Central Food Technological Research Institute, Mysore, by Kirloskar Consultants Ltd., Poona, India. In addition to providing data on consumption of milk and on milk-drinking habits, the survey refers to the extent of popular acceptance and use of MILTONE, a new vegetable milk-animal milk mixture.

CIAT. 1971. Annual report. Centro Internacional de Agricultura Tropical, Cali, Colombia. 120 pp.

CIMMYT. 1970-71. Annual report. International Maize and Wheat Improvement Center, El Batan, Mexico. 114 pp.

FAO/SIDA. 1972. International seminar on food promotion. Report of joint meeting of FAO and Swedish International Development Association, Istanbul, Turkey, 4-13 October 1971. FAO, Rome, Italy. 154 pp. (A brief account of this seminar was published in PAG Bulletin Volume II, No. 1, 1972, page 33).

Jones, B. D. 1972. Methods of aflatoxin analysis. Publication G 70. Tropical Products Institute, London, England. 58 pp.

Kon, S. K. 1972. Milk and milk products in human nutrition. FAO Nutritional Studies No. 27 (second edition, revised). Rome, Italy. 80 pp.

Latham, M. C. 1972. Planning and evaluation of applied nutrition programmes. FAO Nutritional Studies No. 26. Rome, Italy. 125 pp.

Singer, H. 1972. Children in the strategy of development. United Nations Centre for Economic and Social Information, CESI/E. 12;

UNICEF Executive Briefing Paper 6. 64 pp.

Smart, K. F. (ed.). 1972. Malnutrition and endemic diseases: their effects on education in the developing countries. Unesco Institute for Education, Hamburg, Germany. Educational Research and Practice 3. 135 pp.

USAID. 1972. A study of food habits in Calcutta. Published by Hindustan Thompson Associates Ltd., Calcutta, for U.S. Agency for International Development, c/o American Embassy, New Delhi-21, India.

Vahlquist, B. (ed.). 1972. Nutrition: a priority in African development. Proceedings of a Dag Hammarskjöld Foundation Symposium. Almqvist and Wiksell, Stockholm, Sweden. 227 pp. (A brief account of this symposium was published in PAG Bulletin Volume II, No. 1, 1972, page 34).

WHO. 1972. Workshop on the development of education and information materials on family health. WPRO 9605. WHO Regional Office for the Western Pacitic, Manila Philippines. 87 pp.

MEETINGS

February 26 - March 1, 1973	POTENTIALS OF FIELD BEANS AND OTHER FOOD LEGUMES IN LATIN AMERICA Contact: Dr. E. Alvarez-Luna, Centro Internacional de Agricultura Tropical (CIAT), Apartado Aereo 67-13, Cali, Colombia	Cali, Colombia
September 5-12, 1973	SECOND INTERNATIONAL CONGRESS OF PLANT PATHOLOGY Contact: Dr. D. J. Mirocha, Dept. of Plant Pathology, Univ. of Minnesota, St. Paul, Minn. 55101, U.S.A.	Minneapolis, Minnesota

ERRATUM

The account of the SCP symposium published in PAG Bulletin Volume II, Number 4, 1972, on page 32 contains an error of fact. The capacity of the British Petroleum plant in Lavera should be expressed in tons rather than pounds.

PAG MEMBERS 1972-1973

Dr. O. Ballarin
Rua Baurú, 205
Paecambú
ZC 01248
Sao Paulo, SP, Brazil

Professor M. Cépède (Vice-Chairman)
Professeur à l'Institut National Agronomique
c/o Comité Interministériel de l'Agriculture
et de l'Alimentation
78, rue de Varenne
Paris 7ème, France

Professor Joaquín Cravioto
Macuiltepec 77
Campestre Cherubusco
México 21, D. F., México

Dr. A. W. Holmes,
Director
British Food Manufacturing Industries
Research Association
Randalls Road
Leatherhead, Surrey, England

Dr. Nezih H. Neyzi
PEVA
Imam Sok. 5/3
Beyoglu
Instanbul, Turkey

Professor A. A. Pokrovsky
Director
Institute of Nutrition of the Academy of
Medical Sciences of the U. S. S. R.
Ustinsky pr. 2/14
Moscow G-240, U. S. S. R.

Professor Dr. Hans Ruthenberg
University of Hohenheim
Hohenheim, Germany

Professor Nevin S. Scrimshaw (Chairman)
Head
Department of Nutrition and Food Science
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139, U. S. A.

Professor Dr. Selo Soemardjan
Jalan Kebumen 5
Jakarta, Indonesia

Dr. M. S. Swaminathan
Director-General
Indian Council of Agricultural Research
and Secretary to the Government of India
Krishi Bhavan, New Delhi-1, India

Dr. Bo Vahlquist
Director
Department of Pediatrics
University Hospital
Uppsala, Sweden

Dr. Koichi Yamada
Technical Adviser
Sapporo Breweries Ltd.
4-1 Mita 1 Chome, Meguro-ku
Tokyo 153, Japan

PAG STATEMENTS AVAILABLE

No.	Title	Date	Published in PAG Bulletin
2	PAG Recommendation on aflatoxin	1969	
3	PAG Statement on the nature and magnitude of the protein problem	1971	No. 12
4	PAG Statement on single cell protein	1970	No. 11
5	PAG Statement on the marketing and distribution of protein-rich foods	1971	No. 12
6	PAG Statement on milk substitutes	1970	
7	PAG Recommendation on prevention of food losses and protein-calorie malnutrition	1969	
8	PAG Statement on plant improvement by genetic means	1970	
9	PAG Recommendation on amino acid fortification of foods	1970	
10	PAG Statement on a systems approach to the formulation and evaluation of nutrition intervention programmes	1970	
11	PAG Statement on leaf protein concentrate	1970	
12	PAG Statement on the world protein problem: research and development needs	1971	No. 12
13a	Review of the specific proposals contained in ACAST report "International Action to Avert the Impending Protein Crisis" United Nations, 1968	1971	
14	PAG Statement on marketing of conventional foods	1971	No. 12
15	PAG Statement on popular participation and community involvement in nutrition improvement programmes	1971	
16	PAG Statement on the potential of fish protein concentrate for developing countries	1971	Vol. II, Nos. 2 and 3
17	PAG Statement on low lactase activity and milk intake	1972	Vol. II, No. 2
18	PAG Statement on relationship of pre- and postnatal malnutrition in children to mental development, learning and behavior	1972	Vol. II, No. 2
19	PAG Statement on maintenance and improvement of nutritional quality of protein foods	1972	
20	PAG Statement on the "protein problem"	1973	Vol. III, No. 1
21	PAG Statement on specifications for solvents	1972	
23	PAG Recommendations for the promotion of processed protein foods for vulnerable groups	1972	Vol. II, No. 3

PAG GUIDELINES AVAILABLE

No.	Title	Date	Published in PAG Bulletin
2	PAG Guideline for preparing food-quality groundnut flour	1970	
4	PAG Guideline for preparation of edible cottonseed protein concentrate	1970	
5	PAG Guideline for edible, heat-processed soy grits and flour	1969	
6	PAG Guideline for preclinical testing of novel sources of protein	1970	
7	PAG Guideline for human testing of supplementary food mixtures	1970	
8	PAG Guideline on protein-rich mixtures for use as weaning foods	1972	No. 12

No.	Title	Date	Published in PAG Bulletin
9	PAG Guideline on fish protein concentrate	1971	No. 12
10	PAG Guideline on marketing of protein-rich foods in developing countries	1971	
11	PAG Guideline for the sanitary production and use of dry protein foods	1972	Vol. II, No. 3
12	PAG Guideline on the production of single cell protein for human consumption	1972	Vol. II, No. 2
13	PAG Guideline for the preparation of milk substitutes of vegetable origin and toned milk containing vegetable protein	1972	Vol. III, No. 1
14	PAG Guideline on the preparation of defatted edible sesame flour	1972	Vol. III, No. 1

PAG REPORTS AVAILABLE

1.	Feeding the preschool child: report of a PAG ad hoc working group	1971
2.	Manual on feeding infants and young children (Cameron and Hofvander)	1972

PAG Statements and Guidelines may be used and quoted freely. Please note that some of these have been published, as indicated, in previous issues of the PAG Bulletin. Single copies may be obtained without charge from the Protein Advisory Group of the United Nations System, N. Y. 10017, U. S. A. This material may be reproduced for personal use.

The Pan American Sanitary Bureau has translated PAG Statements 1 through 12 into Spanish. They are published in that organization's Bulletin Vol. LXXIII, No. 5, November 1972. Requests for this issue of the publication should be directed to:

Dr. R. Rueda-Williamson
Pan American Health Organization
525 Twenty-third St., N. W.
Washington, D. C. 20037, U. S. A.